AIR PASSENGER DEMAND FORECASTING FOR PLANNED AIRPORTS, CASE STUDY: ZAFER AND OR-GI AIRPORTS IN TURKEY

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ABSTRACT

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The economic evaluation of a new airport investment requires the use of estimated future air passenger demand.Today it is well known that air passenger demand is basicly dependent on various socioeconomic factors of the country and the region where the planned airport would serve. This study is focused on estimating the future air passenger demand for planned airports in Turkey where the historical air passsenger data is not available.For these purposses, neural networks and multi-linear regression were used to develop forecasting models.

As independent variables,twelve socioeconomic parameters are found to be significant and used in models. The available data for the selected indicators are statistically analysed and it is observed that most of the data is highly volatile, heteroscedastic and show no definite patterns. In order to develop more reliable models, various methods like data transformation, outlier elimination and categorization are applied to the data.Only seven of total twelve indicators are used as the most significant in the regression model whereas in neural network approach the best model is achieved when all the twelve indicators are included. Both models can be used to predict air passenger demand for any future year for Or-Gi and Zafer Airports and future air passenger demand for similar airports.

Regression and neural models are tested by using various statistical test methods and it is found that neural network model is superior to regression model for the data used in this study.

Keywords: Airports, Air Transport, Demand Forecasting, Artificial Neural Networks, Multi-Linear Regression Analysis

ÖZ

PLANLANAN HAVALİMANLARININ YOLCU TALEP MİKTARLARININ TAHMİN EDİLMESİ: ZAFER VE OR-Gİ HAVALİMANLARI ÖRNEĞİ

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Yeni havalimanı yatırımlarının ekonomik değerlendirmesi için gelecekte oluşacak trafik miktarının kullanılmasına gereksinim duyulmaktadır. Planlanan havalimanlarındaki yolcu sayılarının, ülkedeki ve inşa edildikleri bölgelerdeki sosyo-ekonomik göstergelere bağlı olduğu günümüzde iyi bilinmektedir. Bu çalışmada Türkiyede yapımı planlanan ve geçmiş veriye sahip olmayan havalimanlarındaki yolcu sayısının tahmini üzerine yoğunlaşılmış ve yapay sinir ağları ile regresyon metodları kullanarak modeller oluşturulmuştur.

Bağımsız değişken olarak oniki adet sosyoekonomik göstergenin önemli olduğu anlaşılmış ve modellerde kullanılmıştır. Bu göstergelerin oluşturduğu veriler istatistiksel olarak değerlendirilmiş ve çoğunluğunun devamsız, herhangi bir düzen göstermeyen ve değişken varyans özelliğine sahip olduğu görülmüştür. Daha güvenilir modeller oluşturabilmek için veri dönüşümü, dışadüşen elenmesi ve veri sınıflandırması yapılması gibi metodlar uygulanmıştır. En iyi regresyon modelinde oniki adet göstergeden yedi adedi kullanılmıştır. Yapay sinir ağlarının kullanıldığı modelde ise göstergelerin tamamı kullanıldığında en iyi sonuç elde edilmiştir. Her iki model de Zafer, Or-Gi veya benzeri bir havalimanında herhangi bir yılda oluşabilecek yolcu sayısını tahmin etmek için kullanılabilir.

Regresyon ve yapay sinir ağları modelleri istatistiksel metodlar ile test edilmiş ve bu çalışmanın incelediği veri kümesinde yapay sinir ağları modelinin regresyon modelinden daha iyi sonuçlar verdiği görülmüştür.

Anahtar Kelimeler: Havalimanları, Hava Ulaşımı, Talep Tahmini, Yapay Sinir Ağları, Çoklu Lineer Regresyon Analizi

To Family, Friends and Loved Ones,

To Pioneers of Arts and Sciences, the Giants on Whose Shoulders We Stand.

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ANN	Artificial Neural Networks
ANOVA	Analysis of Variance
AT	Anatolian Tigers
df	Degrees of Freedom
DHMI	General Directorate of State Airports Authority
DPT	State Planning Institute
GDP	Gross Domestic Product
GDPPC	Gross Domestic Product per Capita
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
KGM	State Directorate of Highways
Ln	Natural Logarithm
MAPE	Mean Absolute Percentage Error
ME	Mean Error
MLP	Multi Layer Perceptron
MSE	Mean Squared Error
PAX	(Number of) Passengers
$\mathbf{R^2}$	Coefficient of Determination
RA	Rural Anatolia
RBF	Radial Basis Function
Sqrt	Square Root
TC	Tourism Cities
THY	Turkish Airlines
TUIK	Turkish Statistical Institute

CHAPTER 1

INTRODUCTION

Transportation has always been an indispensible need of mankind because it generates wealth, comfort and ease of life. In modern life, air transportation became one of the most important modes of transportation. Air transportation can be defined as a form of transportation of goods and people from one place to another by using air ways. It gets attention from the public because it is mostly considered as fast, economic, efficient and a reliable way of transportation, especially for the journeys longer than 500 kilometers.

Air transportation affects millions of peoples' everyday life. Aviation transports close to 2 billion passengers annually and 40% of interregional exports of goods by value. The air transport industry generates a total of 29 million jobs globally. 25% of all companies' sale is dependent on air transport. 70% of businesses report that serving a bigger market is a key benefit of using air services (The Air Transport Action Group, Subdivision of ICAO, 2010). The world's 900 airlines have a total fleet of nearly 22.000 aircraft (ICAO Annual Report of the Council, 2004). Some 40% of international tourists now travel by air, up from 35% in 1990 (Economic Contribution of Civil Aviation, ICAO, 2004).

Air transportation is a complex activity and it requires high tech tools and equipments, communication systems, qualified manpower, complicated infrastructure, national and international rules and laws, etc. In the heart of all these requirements lie airports. Airports are complex structures where aircraft land and take off.

Airports compromise of two parts, as airside and landside. Airside includes runways, taxiways, aprons and holding bases whereas landside covers terminal buildings, internal circulation roads and auto parking systems. Each side contains different structures, which require detailed design analysis before making any investment. The design analyze is based on the traffic forecasting which determines the demand. This forecasted demand enables the airport structure to be sized and designed accordingly. The size and the geometry of an airport directly influence the capital costs of the airports.

Recently in Turkey, air transportation is in an increasing trend and this increase requires new airport investments. New airport investments in Turkey can be categorized as modernization investments, renovation investments and new construction investments. During planning phase of these investments, past traffic data is being used for design year traffic. But when there is no past data available, General Directorate of State Airports Authority (DHMI) has no scientific approach for such problems and forecasting is made by obtaining forecasting values from similar airports. In this study this gap was realized and it is focused on forecasting of air passenger traffic in a region which does not have past traffic statistics.

1.1 Definition of the Problem:

This thesis focuses on estimating air passenger demand for *planned* airports which are investigated during investment phase. It is important to find the correct level of demand before making such investments because they are expensive, take long time to construct and affect too many people.

"It is evident that the forecasting process can be the most critical factor in the development of the airport" (Howard, 1974). "Mistakes made in this phase of the process may be very costly and damaging for local economies. Underestimating demand may lead to increased congestion, delay and lack of storage facilities, as it happened in Venezuela in 1974. The discovery of oil resulted in dramatic and unforeseen increase of the freight volumes handled by the Caracas Airport" (Karlaftis, 2008). Overestimating demand could also create significant problems. Forecasts of passenger demand for the Newark Airport were so high that the newly constructed airport remained empty for a number of years (de Neufville, 1976). Similarly many airports in Turkey opened and stayed idle for years (DHMI, Statistics Yearbook, 2009).

Since this thesis focuses on forecasting air passenger demand of planned airports, the answers to following related questions will be investigated through the study.

1) How can a forecasting study be carried out when there is no historical data available related to the problem?

2) Which forecasting methods can be used when data is limited and/or has a lot of missing values and shows no definite pattern?

3) How can artificial neural networks be applied to forecasting?

4) What are the significant factors that affect demand for air transportation?

Methods which are studied in this text may be useful for forecasters and decision makers who have to decide whether or not to implement a costly and significant transportation or other investments.

1.2 Literature Review

In literature, various studies which focus on determining air passenger demand were found. Important ones are listed below:

In 1957, Port of New York Authority announced a study called “Air travel forecasting 1965-1975”. This study focused on time series analysis and empirical formulas. Variables like revenue-passenger-miles, population, market analysis, characteristics of the industries were used in the analysis and survey analyses were included as well. No specific airport was chosen and a general model was formed for travel in the United States.

International Civil Aviation Organization (ICAO) is a civil organization which works under United Nations. This institution regulates and promotes aviation around the world. They published a handbook in 1985 titled “Manual on Air Traffic Forecasting”. In this manual trend projection techniques which are based on time series analysis were discussed and applications of multi-linear regression were studied too. Also econometric methods and survey analysis were mentioned. Riyadh Airport in Saudi Arabia, Logan International Airport in United States, Western European Airports, Newark Airport in United States, and Abidjan International Airport in Ivory Coast were the case studies of this manual.

Taneja published a paper about statistical evaluation of econometric air travel demand models in 1975. In his work he studied regression models. He points out that judging high R^2 values may not be enough for deciding multimillion-dollar investments.

Neufville and Odoni published a book named “Airport systems: planning, design, and management” in 2003. In this book they mentioned about problems and importance of forecasting before making investments and gave real life examples.

Karlaftis published a paper in 2008 about demand forecasting in regional airports. He studied Corfu Airport in Greece as case study. He studied time series for modeling traffic by choosing tourism and macro-economic indicators.

Profillidis studied demand in the airport of Rhodes using econometric and fuzzy models in 2000. He analyzed the relationship between transport and economic activity. In his study appropriate models for demand forecast for tourist airports with high seasonal demands were analyzed. Market surveys, statistical methods, econometric models and the fuzzy method were used for establishing relationships. Tourism and macro-economic indicators were used in his study.

Naudé & Saayman investigated determinants of tourist arrivals in Africa using panel data regression analysis.

Abbas studied passenger demand prediction in Cairo Airport using regression models.

Abed, Abdullah, Ba-Fail and Jasimuddin studied econometric analysis of international air travel demand in Saudi Arabia in 2000. They used stepwise regression technique and found out that a model with total expenditures and population size is the most appropriate model to represent the demand for international air travel in Saudi Arabia.

Rengaraju and Arasan studied use of regression and econometric models for determining air travel demand in 40 city pairs in India. They used two-way weekly air travel as the dependent variable and various socioeconomic independent variables. Stepwise multiple linear regression was used in their analysis.

Gentry, Wiliamowski and Weatherford studied use of neural networks in air travel demand in 1995. They compared neural and regression prediction performances and found that neural forecast model performed better.

Alekseev and Seixas studied neural forecasting modeling for air transport in Brazil in 2009. They found that neural processing outperforms the traditional econometric approach and offers generalization on time series behavior, even where there are only small samples.

Law and Au studied a neural network model to forecast Japanese demand for travel to Hong Kong in 1999. They found out that using a neural network model to forecast Japanese arrivals outperforms multiple regression, naïve, moving average and exponent smoothing methods.

Ba-Fail studied Saudi Arabian domestic and international air passengers. He found that oil gross domestic product, population size and GDPPC were the most contributing variables that affect the number of passengers in the Saudi Arabian airline sectors.

Although all these studies provided brilliant solutions and promoted satisfactory methods, none of them studied a new planned airport. Also all the studies mentioned above considered links between socioeconomic indicators and travel demand. For example Saudi studies considered oil production, Greek studies considered number of tourists and Indian researches investigated number of workers abroad etc. In other words, every forecasting study focused on unique *socioeconomic indicators* which are suitable and available for the country. Significance of socioeconomic indicators will be mentioned in the next section.

1.3 Approach to the Problem:

Socioeconomics and transportation have a strong relationship with each other and it can be said that transportation itself is a socioeconomic activity. Turkish Ministry of Culture and Tourism prepares questionnaires annually and ask questions to the passengers about their reasons for travel. The reasons behind transportation are like this: touristic trips, religious visits, family visits (weddings, anniversaries, regular visits, etc.) , medical reasons, educational reasons, cultural and sports events, commercial relations, shopping, meetings, courses, conferences, seminars, job related travel, exhibitions, etc. All these answers point to socioeconomic activities. In this study it is also aimed to measure socioeconomic indicators and link them with transportation need.

Various transportation forecasting models were developed like demand models, network models, traffic models, performance models, four step models and similar. In this thesis none of these specific methods were used for determining air passenger demand but partial properties of the mentioned models were applied. Transportation models and their assumption details are discussed in further chapters.

Studying with planned airports has two major problems: First, there is no available past passenger data and second; especially in Turkey and emerging nations, volatility in political, social and economical situation of the country.

In order to deal with lack of data problem, it is decided to analyze and categorize existing similar airports' data and relates them to socioeconomic indicators thus yield a general model for airports in Turkish heartland. After investigating these indicators it was observed that there is high volatility and statistical noise with them. Volatility and statistical noise of the data can be described as a situation where data is out of any definite patterns, show no homogeneity and strong cause-effect relationship and lack of normal distribution. Studying with this type of data is very difficult and it can be said that most of the emerging and developing nations suffer from similar problems. Various methods which will be studied in the following chapters will be used for eliminating those effects. Forecasting methods that are proven to give better results for limited data are studied in Chapter 2 and Chapter 3. Details of data collection can be found in Chapter 4. Data analysis methods were studied in Chapter 5.Two case studies were investigated which are planned Zafer and Or-Gi airports in Turkey. Details of these airports can be found in succeeding parts of this chapter.

1.4 Overview of Turkey and Aviation in Turkey:

Turkey is a transcontinental country occupying 783.562 square km. land located partly in Europe and Asia. It has coasts aligning Black Sea, Mediterranean Sea, Aegean Sea and an inner sea called Marmara. According to TUIK (Turkish Statistical Institute), Turkey has a population of 73 million as of mid-2010 and has an average population increase of 1.5% annually. Approximately 70% of the population resides in urbanized areas and rate of urbanization is still increasing. Turkey has a 614.603 billion dollar Nominal GDP and 13.905 dollars GDP per capita as of 2009 (World Bank).

Aviation activities started in Turkey in 1909 by Ottoman Air Force for military activities. First civil flight was made in 1933 by State Airline Operations (in Turkish: "Devlet

Havayolu İşletmesi", equivalent of modern Turkish Airlines). In 1947, first international flight was made to Athens. After the end of Cold War by the effect of economic globalization, total number of Turkish air passenger transportation started to increase. This resulted in the construction of airports in many provinces in Turkey as of 2010. There are 46 airports available for civil commercial aviation use in Turkey. Some cities have more than one airport (Antalya, Balıkesir, Muğla, and Istanbul) and some airports are closed to air traffic due to economical or other reasons (i.e. Afyon). In Fig.1.1, a map presented which shows domestic and international airports. The list of current active airports is given in Table 1.1. and number of passengers is given in Appendix A.

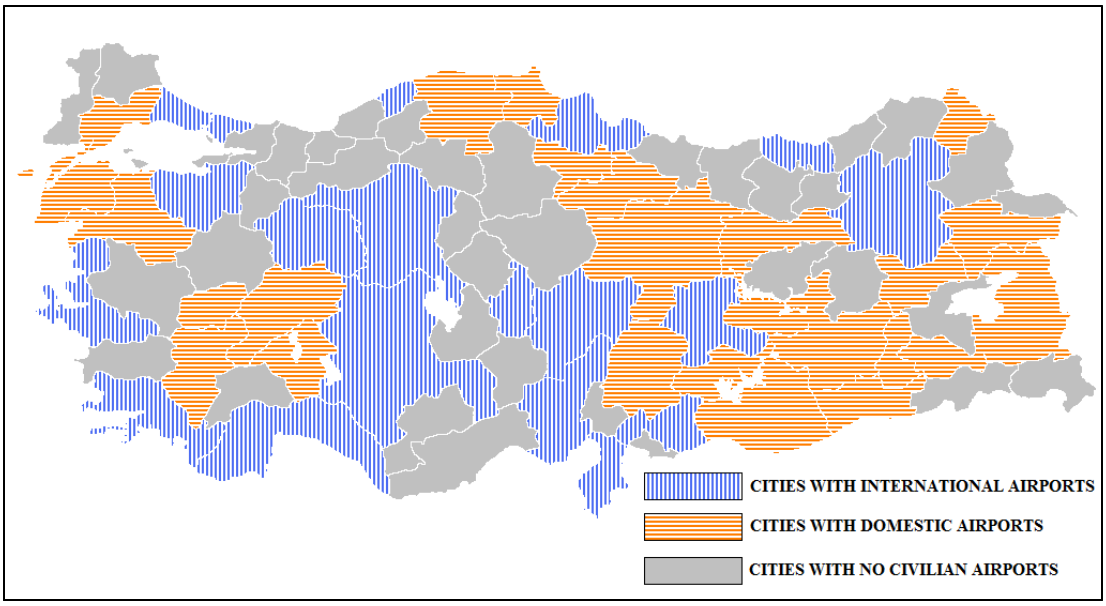

Fig.1.1 Cities That Have International and Domestic Airports in Turkey

1.5 Information about Planned Zafer Airport:

Zafer airport is one of the case studies of this thesis. It is planned as a multi-regional airport in Aegean region of western Turkey to serve cities of Afyon, Uşak and Kütahya. Uşak has an active airport and option of keeping it open is still under investigation. Altıntaş district of Kütahya is the planned location of the Zafer Airport. Its distance to city centers will be approximately 57 kilometers to Afyon, 84 kilometers to Uşak and 50 kilometers to Kütahya respectively. The location of Zafer Airport is shown in Fig.1.2. Zafer airport may serve cities of -Kütahya and Afyon- or -Kütahya, Afyon and Uşak- together. In further parts of this study Zafer_2 refers to scenario of serving two cities and Zafer_3 refers to serving Kütahya, Afyon and Uşak together.

Table 1.1 List of Civilian Airports in Turkey as of end of 2009

No	City	Name of Airport	Type	Current Condition
1	Adana	Şakirpaşa	International	Active
2	Adıyaman	Adıyaman	Domestic	Active
3	Afyon	Afyon	Domestic	Closed to air traffic
4	Ağrı	Ağrı	Domestic	Active
5	Amasya	Amasya Merzifon	Domestic	Active
6	Ankara	Esenboğa	International	Active
7	Antalya	Antalya	International	Active
8	Antalya	Alanya Gazipaşa	International	Active
9	Balıkesir	Balıkesir	Domestic	Idle
10	Balıkesir	Balıkesir-Körfez	Domestic	Active
11	Batman	Batman	Domestic	Active
12	Bursa	Bursa-Yenişehir	International	Active
13	Çanakkale	Çanakkale	Domestic	Active
14	Denizli	Denizli-Çardak	Domestic	Active
15	Diyarbakır	Diyarbakır	Domestic	Active
16	Elazığ	Elazığ	Domestic	Active
17	Erzincan	Erzincan	Domestic	Active
18	Erzurum	Erzurum	International	Active
19	Eskişehir	Eskişehir Anadolu	International	Active
20	GaziAntep	Gaziantep Oğuzeli	International	Active
21	Hatay	Hatay	International	Active
22	Isparta	Isparta S. Demirel	Domestic	Active
23	İstanbul	İstanbul-Atatürk	International	Active
24	İstanbul	Sabiha Gökçen	International	Active
25	İzmir	İzmir Adnan Menderes	International	Active
26	K.Maraş	Kahramanmaraş	Domestic	Active
27	Kars	Kars	Domestic	Active
28	Kayseri	Kayseri Erkilet	International	Active
29	Konya	Konya	Domestic	Active
30	Malatya	Malatya Erhaç	International	Active
31	Mardin	Mardin	Domestic	Active
32	Muğla	Muğla-Bodrum	International	Active
33	Muğla	Muğla-Milas-Dalaman	International	Active
34	Muş	Muş	Domestic	Active
35	Nevşehir	Nevşehir-Kapadokya	International	Active
36	Samsun	Samsun-Çarşamba	International	Active
37	Siirt	Siirt	Domestic	Active
38	Sinop	Sinop	Domestic	Active
39	Sivas	Sivas	Domestic	Active
40	Şanlıurfa	Şanlıurfa-GAP	Domestic	Active
41	Tekirdağ	Tekirdağ-Çorlu	Domestic	Active
42	Tokat	Tokat	Domestic	Idle
43	Trabzon	Trabzon	International	Active
44	Uşak	Uşak	Domestic	Active
45	Van	Van-Ferit Melen	Domestic	Active
46	Zonguldak	Zonguldak-Çaycuma	Domestic	Active

Overview of Kütahya:

The area of Kütahya is 11.875 square kilometers and mostly consists of mountainous highlands. Population of Kütahya is 571.804 as of end of 2009 and 656.903 as of end of 2000. It can be said that there is a decline trend in the overall population. Urban population was 358.725 as of end of 2009 and 318.869 as of end of 2000. On the other hand, like the rest of the Turkey, urbanization is in increasing trend. GDP per capita is approximately 20% less than average of Turkey between years 2000 to 2010. GDP per capita values were calculated from TUIK (Turkish Statistical Institute) statistics. It has small and medium sized industrial enterprises in organized industrial areas of the city. Also Kütahya has some mining investments and touristic facilities and it can be considered as a medium-small size city.

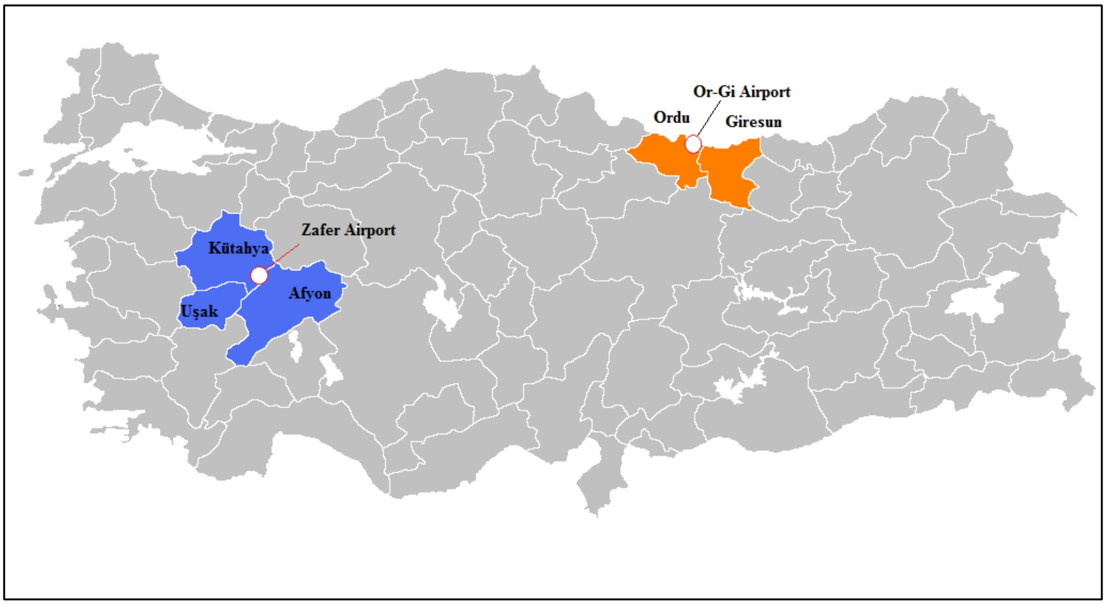

Fig.1.2 Locations of Zafer and Or-Gi Airports and Cities of Kütahya, Uşak, Afyon, Ordu and Giresun

Overview of Uşak:

Uşak is located in Aegean Region having border with Central Anatolian Region. It mostly consists of plateaus and some mountainous regions and has an area of 5.344 square kilometers. Population of Uşak is 322.313 by the end of the year 2000 and 335.860 by the end of the year 2009. Like the rest of the Turkey, urbanization rate is increasing in Uşak. Also urban population has increased from 182.040 people to 221.714 people from year 2000 to 2009. GDPPC of Uşak is approximately stands for 68% of the average Turkish overall

GDPPC. Uşak has moderate mining facilities and has foresting potential (32% of the city is covered with forests). Like Kütahya, Uşak has small and medium sized industrial enterprises in organized industrial areas and it can be considered as a medium-small size city.

Overview of Afyon:

Afyon is located in eastern Aegean region of Turkey and has an area of 14.300 square kilometers. It has both mountainous and flat topographic regions. Like most inner Anatolian cities, Afyon has a decreasing population. Total population of Afyon dropped from 812.416 to 701.326 from 2000 to 2009 where urban population increased from 318.869 to 358.725. GDPPC of Afyon is roughly 60% of the average of overall Turkish GDPPC. Similar to Uşak and Kütahya, Afyon has small and medium sized industrial enterprises in organized industrial areas and it can be considered as a medium-small size city.

1.6 Information about Planned Or-Gi Airport:

Or-Gi airport is the other case study of this thesis. It is also planned multi-regional airport to serve eastern Black Sea region of Turkey. The selected location is in Gülyalı district of Ordu. It is 25 kilometers to Giresun and 19 kilometers to Ordu. The location of Or-Gi Airport is shown in Fig.1.2.

Overview of Ordu:

Ordu is a medium-small size city occupying 5.963 square kilometer area. Ordu has coastline along Black Sea but the rest of the city area is mostly mountainous. Its population decreased from 887.765 to 723.507 and urban population decreased from 416.631 to 399.035 between years 2000 to 2009. Average GDPPC of Ordu is almost 50% of Turkish GDPPC. Ordu does not have a strong industrial infrastructure. Most of the economic activity is based on hazelnut harvesting and processing. It has historical places, museums and coastline but lack of tourism infrastructure.

Overview of Giresun:

Giresun is the eastern neighbor city of Ordu It has also coastline along Black Sea. It is located over a very mountainous region and occupies 6.934 square kilometer area. Both total and urban population decreased from 2000 to 2009 by 887.765 to 723.507 and 416.631 to 399.035 respectively. Average GDPPC of Giresun is approximately 65% of Turkish GDPPC. Hazelnut is the base of the main economic activities. Small industrial enterprises work under organized industrial zones of the city. Like Ordu, Giresun has historical places, museums and coastline but lack of tourism infrastructure. Giresun can be considered as a medium-small size city.

Table 1.2 Basic Properties of the Cities that Planned Airports Will Serve

	Population (2009)	GDPPC (% of Average Turkish GDPPC)	Area (km²)	Industry	Tourism Infrastructure
AFYON	812.416	60%	14.300	Limited	Negligible
KÜTAHYA	571.804	80%	11.875	Limited	Negligible
UŞAK	335.860	68%	5.344	Limited	Negligible
ORDU	723.507	50%	5.963	Negligible	Negligible
GİRESUN	723.507	65%	6.934	Negligible	Negligible

CHAPTER 2

FORECASTING

Forecasting can be defined as a kind of art that practices predicting future events with studying past conditions. Neufville and Odoni (2001) defined forecasting as an art because there can be more than one correct method and subjective to choice of the decision-maker.

Mankind has always been interested in forecasting because it provides wealth, productivity, comfort and ease of life. After hearing the weather forecast, one getting an umbrella with him/herself on the way can be given as an example to the solid comfort provided by forecasting activities.

Almost every discipline in modern science, such as medicine, sociology, psychology, mathematics, economics, etc., uses forecasting methods. Engineers are also interested in forecasting. Various methods are being used by engineers from various disciplines, as well as transportation engineers. Estimating the number of passengers or vehicles on a bridge, highway, airport, seaport or any kind of transportation structure is the main aim of the transportation planners.

A realistic prediction can provide both economic and technical ease to engineers. A correct estimate of future passenger and vehicle number would give an idea about the fact that how much the future structures should be designed in appropriate size, shape, location and geometry. After completing the construction of the investment, public would be satisfied with a comfortable way of transport and government would be pleased with a higher approval of public opinion. If the investment is made by private sector; companies, banks and other investors would be enjoying low-risk turnover rate of the assets which would encourage them to make new investments. This sequence can be seen in Fig. 2.1.

2.1 Forecasting Methods:

There are many forecasting methods in the literature. These methods cannot be classified as “good methods” or “bad methods”. Each of them has its own strengths and own weaknesses.

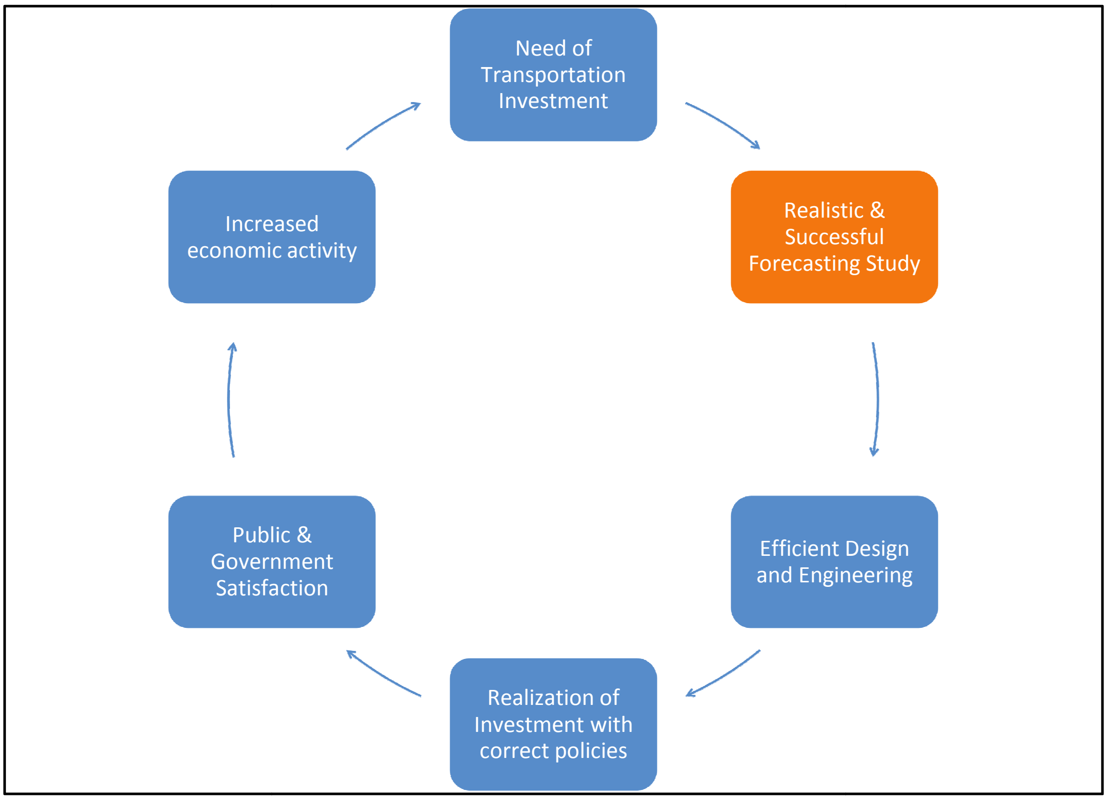

Fig. 2.1 Effect of Successful Forecasting

The breakdown structure of modern forecasting methods in use is given in Fig.2.2.

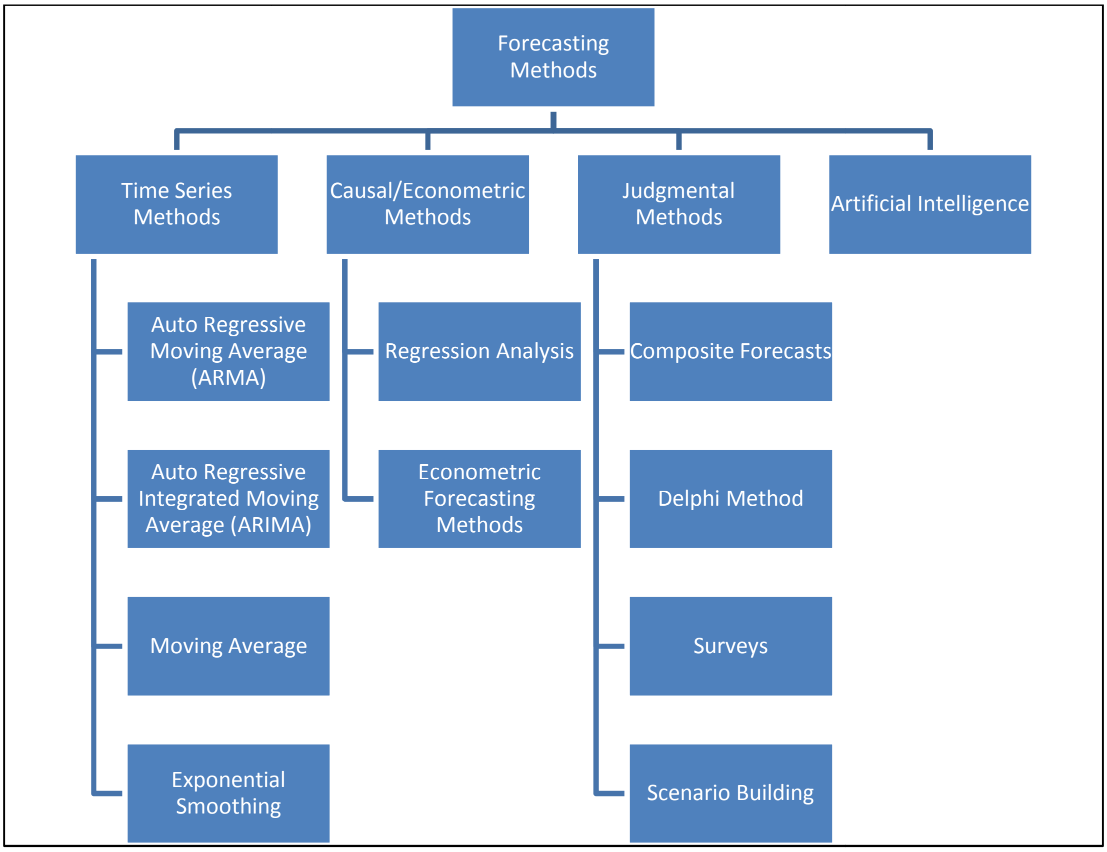

Fig. 2.2 Breakdown of Forecasting Methods

Some forecasting methods may be suitable when lots of data are available and some may be useful when there is limited or missing data. It is important for a forecaster to pick suitable forecasting method for available data. Some widely used forecasting methods are discussed in subsequent sections.

Time Series Forecasting:

Time series is a set of regular time-ordered observations of a quantitative characteristic of an individual or collective phenomenon taken at successive, in most cases equidistant, periods / points of time (OECD glossary of statistics, 2010). Stock market values, river flows, atmospheric measurements can be given as examples to this kind of data. As the name of the method suggests, one of the fixed variable is time itself and this method requires continuous observations. The data can be interpreted with various techniques like graphical approach, Euler transformations, etc.

Judgmental Methods:

When there is no or only limited data, judgmental methods become useful for forecasters. These techniques deal with qualitative data like surveys, expert opinions, customer feedbacks and similar. Human judgment is the main element of these methods and some judgmental methods can be combined with other forecasting methods. Judgmental methods may also be useful when forecasting environment is highly volatile and it is very difficult to apply any mathematical model.

Causal Methods:

These methods rely on existence of cause-effect relationships between factors. For example increased economical activity may result in increased transportation activity. In literature causal methods sometimes called as “econometric methods” or “causal/econometric methods”. In this method, variables that cause reaction on forecasted data should be chosen with care. Irrelevant variables may complicate the overall model which increases error and forecaster may get unexpected or wrong output from the model. Regression analysis, which can be classified under causal methods, will be studied in detail in Chapter 3.1.

Artificial Intelligence Methods:

Artificial Intelligence (AI) can be used for forecasting activities. AI models can be applied where there is any input-output or cause-effect relationship. In Section 1.2, AI studies which are focused on air passenger demand forecasting were given. Various AI studies like predicting wind, gas consumption, light-rail system usage and similar forecasting studies can be found in the literature. This method will be studied in detail in Chapter 3.2.

2.2 Comparing and Selecting Forecasting Methods:

As it was mentioned before, there are many different forecasting methods that each has own strengths and vulnerabilities. In order to form an accurate forecasting model, correct method should be chosen. Table 2.1 displays more specific characteristics of widely used forecasting methods and their comparison.

Table 2.1 Forecasting Model Comparisons

FORECASTING MODELS COMPARISONS			
	TIME-SERIES	CAUSAL/REGRESSION	NEURALNETWORKS
ADVANTAGES	Suitable when data is observed in equidistant time intervals	Suitable when there are known relationships between predictors and prediction	Can work with any kind of data
	Can analyse seasonality effects better than other methods	Can work without time indicator	Missing data does not cause problem as much as other methods
		Can answer classification problems	Can work with less data
			Can work without time indicator
			Can answer classification problems
DISADVANTAGES	Time is the main dependent variable	Fails if there is weak or no relationship between predictors and prediction	Works Black-box. (It is not possible to understand inner mechanisms)
	Needs data in a series form.	May give unreasonable results if there is a lot of missing data or not enough observations	May need trial-and-error
	Needs relatively more data than other forecasting methods	May give unreasonable results if data is heteroscedastic	
	Less tolerant to missing data	May not be suitable if data is not normally distributed	

In this study, a highly volatile dataset which has a lot of missing values and shows no definite patterns is used. Because of this uncertainty in the data, time-series methods were not considered as an option. If a single airport with monthly data was studied, these methods would be more suitable.

Causal methods are known to be satisfactory with strong cause-effect relationships, particularly with the linear ones. In real life data, like this study investigates through, it is difficult to find strong linearity (or non-linearity) and strong cause-effect interactions. But there are various methods to overcome those problems thus it is decided to use regression method as well. Also regression analysis can give an idea of the nature of the data and display significance analysis of the entered variables to the model. It is decided that comparing statistical errors of both models would provide an idea for model selection with improperly distributed data.

Considering the uncertainties, volatile trend in air travelling market, missing values and available data, it is decided to use artificial neural networks and regression methods in this study.

CHAPTER 3

FORECASTING METHODS
FOR
DETERMINING PASSENGER DEMAND

In this chapter two prominent forecasting methods are studied, which are regression analysis and neural network forecasting models. The reasons behind choosing these methods were discussed in Chapter 2.In Section 3.3 various tests and methods for verifying forecasting models were mentioned. Application of the methods discussed in this chapter will be exercised in detail in Chapter 5.

3.1 Regression Methods:

Regression analysis is a powerful forecasting tool which is used in many areas such as engineering, sociology, psychology, etc. It is a statistical and mathematical method suitable for determining relationship between one variable and altering other(s). Mendenhall and Sincich (1992) states that, models that relate a dependent variable "y" to a series of independent variables "$x_{1.}x_2, \ldots, x_k$" are known as regression models.

3.1.1 Types of Regression:

There are various regression models used in scientific studies. Important regression models and their area of use are defined below:

- Simple Linear Regression Model: It is the simplest regression model. Only one dependent and independent variable used in a linear equation. Resultant function is $y = ax + b$.
- Multi-Linear Regression Model: It is similar to simple linear regression model and linear equations are used. Main difference is more than one independent variable

included. Resultant function is $y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon$. In this equation β_0 refers to equation constant and ε refers to residual of errors.

- Non-Linear Regression Model: “Nonlinear regression is characterized by the fact that the prediction equation depends nonlinearly on one or more unknown parameters. It usually arises when there are physical reasons for believing that the relationship between the response and the predictors follows a particular functional form” (Smyth, 2002).
- Logistic Regression Model: It is used for prediction of the probability of occurrence of an event by fitting data to a logit function logistic curve.
- Binary Regression: This method can be considered as a subcategory of logistic regression. It is suitable for predicting binary situations.
- Regression Trees: This method is suitable for solving categorization problems.

3.1.2 Multi-Linear Regression:

In this research, multi-linear regression will be studied in detail. The data used in this study does not show any particular linear and/or nonlinear trend. But it shows an increase trend between variables, like more crowded communities tend to travel more (Analysis of the data in detail can be found in Chapter 5). Because of the nature of the problem, logistic regression types are not suitable but non-linear models could have been an option. When the data is analyzed in detail in the preliminary studies, it is observed that there was no significant non-linear relation between variables. Because of the lack of prominent non-linear relation and increase trends between variables, it is decided to use multi-linear regression in this study.

Assumptions for Regression Models:

Although multi-linear regression models can be applied to any kind of data set, in order to apply a successful model, data should posses some specific characteristics. Those are summarized as follows:

1) *Numbers of Cases :* When doing regression, the cases-to-independent variables ratio should ideally be 20 cases for every independent variable in the model. Lowest ratio should be minimum 5 to 1. (Princeton University, Data and Statistical Services, 2007)

2) *Accuracy of Data :* Like all other forecasting methods, accuracy of the data is important for regression forecasting. It is impossible to get an accurate result from an inaccurate dataset.

3) *Missing Data:* Regression analysis is more tolerant to missing values than time-series analysis but it is certain that accuracy of the analysis has relationship with number of the missing values. After examining data, missing values can be replaced with some other value.

The easiest thing to use as the replacement value is the mean of this variable. Alternatively, substituting a group mean can be used. (Princeton University, Data and Statistical Services, 2007)

4) *Outliers :* Data should be checked for outliers (i.e., an extreme value on a particular item). An outlier is often operationally defined as a value that is at least 3 standart deviations above or below the mean. (Princeton University, Data and Statistical Services, 2007). Also the sample set should be composed of similar observations. For example while measuring transportation needs of emerging nations, there should not be any developed or underdeveloped countries in the sample set.

5) *Homoscedasticity:* Homoscedasticity means where all forms of independent variables, the variance is constant (Mendenhall and Sincich, 1992). Homoscedasticity can be checked by looking at the same residuals plot mentioned in linearity and normality items. The data is homoscedastic if the residuals plot has the same width for all values of the predicted dependent variable. (Princeton University, Data and Statistical Services, 2007). Opposite situation of the homoscedasticity is known as heteroscedasticity.

6) *Linearity:* As the name suggests, multi-linear regression focuses on determining the *linear* relationships between dependent and independent variables. Linear relationship means there is linear cause and effect interaction between variables.

Linearity between independent variable and the dependent variable can be tested by looking at a bivariate scatterplot (i.e., a graph with the independent variable on one axis and the dependent variable on the other). If the two variables are linearly related, the scatterplot will be oval. (Princeton University, Data and Statistical Services ,2007).

7) *Normality:* Normality is a sign of homoscedasticity, homogenity and linearity of the data , all of which are required by multi-linear regression. Normality of the data can be checked by analysing histograms. Another way is looking at the plot of the “residuals”. Residuals are the difference between obtained and predicted independent variable scores. If the data are normally distributed, then residuals should be normally distributed around each predicted dependent variable score. (Princeton University, Data and Statistical Services ,2007). Skewness and Kurtosis, which measures how symmetrical and how peak the data is respectively, can be studied further to investigate the normality. Values which are greater than +3 or less than -3 are considered as extreme values.

8) *Multicollinearity and Singularity:* Multicollinearity is a condition which the independent variables are very highly correlated (0.90 or greater). When some independent variables are perfectly correlated and one independent variable is a combination of one or more of the other independent variables then this condition is called singularity.

Calculation of the regression coefficients is done through matrix inversion and if singularity exists, the inversion is impossible, and if multicollinearity exists the inversion is unstable. In such a case it can be said that the independent variables are redundant with one another . Having multicollinearity or singularity can weaken the analysis. In general two independent variables that correlate with one another at 0.70 or greater considered correlated (Princeton University, Data and Statistical Services ,2007). The correlation coefficients are computed different than R^2 value and these two values are completely different.

3.1.3 Significance and Validity for Regression Models:

Various test's and control methods are widely used for checking significance and validity of multi-linear regression models. Important tests and methods are mentioned below:

F-Test:

The F value theory suggests that if two data sets are similar, the variance between them should be similar as well. F value is a number greater than 1 and smaller values refer to greater resemblance with the actual observations. F value is also used for student's t-test for determining significance of coefficients. Although F-test is most widely used with regression models, it can be used for comparing any two datasets. Details about this test can be found in Appendix B.

Student's t-test and p-value:

t value, which is also known as student's t-value or t-statistic, is a tool for comparing two datasets. t-test assumes that if two samples are identical, then their standard error should be identical as well. The t-statistic is an estimate of the standard deviation of the coefficient, in other words the amount it varies across cases. Lower values of the p-value stand for more significance of the variables in regression equation. Although many confidence levels may be considered as accepted, most of the scientists find 95% confidence interval as statistically significant ($\alpha < 0.05$). Formulas and details of Student's t-test and p-value can be found in Appendix B.

R-square, Wellness of Fit :

R^2, also known as coefficient of determination, is used for determining how well a linear equation is fitted to a dataset. R^2 gives result as percentage and higher R^2 values show better fit. Perfect line would have a value of 1 (which means error sum of squares, equals to 0). R square adjusted (R^2_{adj}) is a similar term as R^2. Since it includes degrees of freedom, it is more useful to determine if newly added regression coefficient decreases the error mean square. Details and formulas for both coefficients can be found in Appendix B.

3.1.4 Use of Dummy Variables:

It is possible to reflect both qualitative and quantitative values in regression models. In order to reflect effects of qualitative variables in regression equations, use of dummy variables is required. Like quantitative variables, dummy variables should have cause-effect relationship with dependent variable. More information about use of dummy variables can be found in Appendix B.

3.1.5 Studying With Panel Data:

Panel data (also known as longitudinal or cross-sectional time-series data) is a dataset where behaviour of entities is observed across time. These entities could be states, companies, individuals, countries, etc. (Oscar Torres-Reyna, 2006). Panel is extensively used in economics, psychology, sociology and similar sciences.

Constant Coefficients Model:

In this method, there is no categorization of observations made thus no dummy variables exist. All the observations are gathered and an ordinary least squares regression is applied. This method may be useful when the categorization has no statistical significance. This method is also known as pooled regression model.

Fixed Effects Model:

Fixed effect model have different interceptions with respect to different groups (cross-sections) which are modelled with dummy variables. Because of use of dummy variables, sometimes this model is called *Least Squares Dummy Variable Model*. Use of fixed model has both advantages and disadvantages. Use of too many dummy variables may increase multicollinearity. This study is focused on fixed effects Model. The reasons behind choosing fixed effects method can be listed like the following:

- It is easier to conduct than random effects model
- Observations are reflecting the whole case
- Categorization is a necessity which makes use of constant coefficients model impossible.

Random Effects Model:

Random effects model is based on the understanding that variations between dependent variable and independent variables are uncorrelated and show random relation. Random Effects Model may be more suitable when the observations are not modeling the whole set of observations but only a limited sample.

3.2 Neural Networks:

A neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects (Haykin 1998):

1. Knowledge is acquired by the network through a learning process.
2. Interconnection strengths known as synaptic weights are used to store the knowledge.

Neural networks attract many researchers from various disciplines and this interest comes from the flexibility, speed and ease of use. Neural networks can work with any kind of data (linear or non-linear, too little or too many data, qualitative, quantitative or hybrid datasets, etc.). It can be used for classification, data processing, modeling or forecasting purposes. In literature, neural networks are also known as "Artificial Neural Networks" or "ANN"'s.

3.2.1 Neural Architecture & Layers:

In artificial neural networks, neurons are organized in layers. Mostly, each neuron in a layer is connected to the neurons of the further layer. All neural networks have one input, one output and various numbers of hidden layers in the middle segment. Input layer gets only one directional input data from outside of neural network. This layer can be considered as a point where interaction with outside world occurs and outside data is entered to model. Similar to input layer, output layer neurons give one directional data to outside. Number of hidden layers may vary from one to several and their aim is to connect input and output layers.

Interlayer connections can be formed in various types. If each neuron in first layer is connected to each neuron of the second layer, then this type can be identified as "fully connected neurons". But some of the neurons in the first layer may not be connected to further layer neurons. This case is known as "partially connected neurons". In Fig.3.1, a sample neural network model with two hidden layers can be seen. This model is formed with fully connected neurons.

Flow direction of the data can be one directional or bi-directional. If neurons in the network transmits data but do not receive any feedback from the latter layer neurons, this structure is called as feed-forward neural networks. Neural structures which are capable of both sending and receiving information are called as "bi-directional" or "recurrent" neural networks. Both feed-forward and bi-directional neural networks can be fully connected or partially connected.

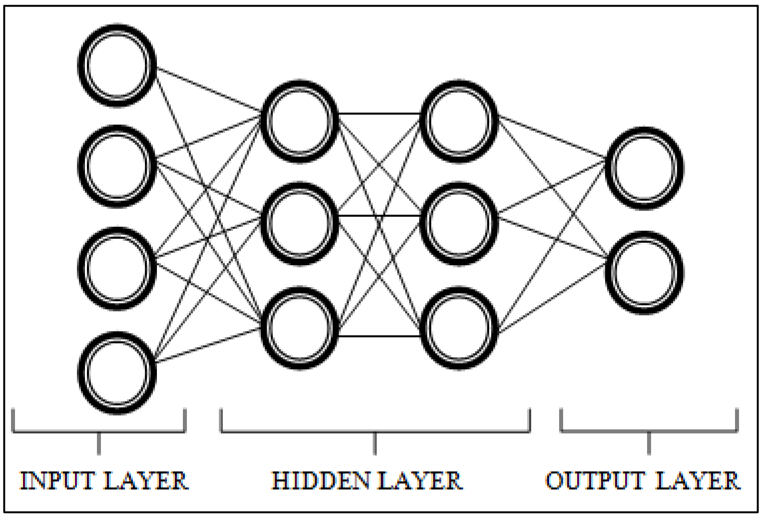

Fig. 3.1 A Sample Artificial Neural Network Model with Two Hidden Layers

Feed-forward neural networks can be further classified into two categories:

- Multilayer Perceptron: Perceptron is the most basic single neuron artificial neural network model developed in 1957 by Robert Rosenblatt. If propagation and output function is assumed as binary responding function then sample neuron in Fig.3.1 can be considered as a single Perceptron. Multilayer Perceptron (also known as MLP) is a feed-forward neural network with numerous perceptrons formed with several hidden and output layers.
- Radial Basis Function: Radial Basis Function (also known as RBF) is a very similar model to multilayer perceptron model. The main difference from MLP is, radial basis function uses radial functions for propagation and output functions. This model may be more suitable in categorization problems and when data is mostly linear.

3.2.2 Learning:

Neural networks can learn from its environment and improve its performance through learning. A neural network learns about its environment through an interactive process of adjustments applied to its synaptic weights and bias levels (Haykin, 1998).

3.2.2.1 Learning Paradigms:

Unsupervised Learning (Learning without a teacher): In unsupervised learning there are no input-output pairs. Once the network has become tuned to the statistical regularities of the input data, it develops the ability to form internal representations for encoding features of the input and thereby to create new classes automatically (Becker, 1991).

Reinforcement Learning: In reinforcement learning, the learning of an input-output mapping is performed through continued interaction with the environment in order to minimize a scalar index of performance (Haykin, 1998). This kind of learning is also considered as a subsection of unsupervised learning.

Supervised Learning (Learning with a teacher): Network is provided with actual input-output pairs and expected to set neural weights according to pattern. Errors are calculated and neural weights are redefined in a way that to minimize the statistical errors. Errors are recomputed from output layer to input layer to determine whether the synaptic weights are correct.

Besides typical learning paradigms, another set of learning classification can be used for defining neural networks:

- Offline Learning: Most of neural networks use offline learning. After the synaptic weights calculated, network enters to an offline stage and run on determined weights. Synaptic weights do not change anymore after entering offline mode.
- Online Learning: Online learning refers to neural networks which train synaptic weights even after entering prediction mode. This method is more suitable with large datasets.

3.2.2.2 Functions:

Together with synaptic weights, propagation and activation functions are the determinants of how neural networks will behave. Mostly used functions are listed below and details of these functions can be found in Appendix C.

- Linear Function
- Threshold Function (Binary Function)
- Sigmoid Function
- Hyperbolic Function

3.2.2.3 Back Propagation:

As it was mentioned before, supervised learning is carried out by set of observed input-output pairs. Back propagation is a method for neural networks to train synaptic weights and it can be defined like this:

Step 1) Initialize synaptic weights with random values

Step 2) Get the first input dataset (independent variables) from observations

Step 3) Forward propagate the data to the output layer

Step 4) Calculate error between prediction and the actual value (dependent variable).

Step 5) Backward propagate new neural weights to the input layer

Step 6) Get further dataset from observations

Step 7) Repeat the procedure until error is minimized

In order to minimize error function, there is a need for dealing and solving large linear equation groups. Although there are many methods like Quasi-Newton, Levenberg-Marquardt, Quick Propagation, etc., two methods in neural network predictions are widely used:

- Scaled Conjugate Gradient Method
- Gradient Descent Method

These methods can be basically described as mathematical tools which are used for searching local and global minimals of a function. More information about these minimization routines can be found in Appendix C.

3.2.2.4 Overtraining:

Sometimes, neural networks train synaptic weights and bias value in a way that model works fine with sample data but generate random predictions with new observations. This situation is known as overtraining and suggests that neurons *memorized* the training data. Memorizing of neurons can be compared to the situation of a schoolchild who knows summation values of certain numbers but do not know the summation operation itself and confuse when he is asked to sum two new numbers he/she doesn’t know. According to Duin (2000), overtraining may be a signal of nonlinearity in data. The following precautions can be taken in order to prevent overtraining:

1) A test sample can be prepared and result may be tracked on it.

2) Statistical noise producing independent variables can be eliminated from the neural model.

3) An early-stop procedure can be applied to model. Most of the neural network software provides such options.

4) Changing the architecture of the model may help. Number of hidden layers or number of neurons in hidden layers can help reducing overtraining.

3.3 Tests & Methods for Verifying Forecasting Models :

Some tests specific to regression analysis were discussed in former parts of this chapter. In this section general tests& methods for comparing forecasting models will be studied. These methods can be used with both regression, neural and other statistical methods as well.

It should be noted that measuring and comparing error values should not be the sole reason for selecting a model. A forecaster should evaluate the results by judgment before deciding. In this study it is observed that some models created inconsistent data but provide very low error values since the estimators were computed in such distribution.

Mean Error (ME):

Mean error is calculated by adding individual forecast errors to each other. In an ideal forecast result, ME should be zero as summation of positive and negative errors cancel each other.

$$ME = \frac{1}{n}\sum_{k=1}^{n} y_k - \hat{y}_k \qquad \text{Eqn.3.1}$$

Mean Squared Error (MSE):

Mean Squared Error (MSE) is the sum of the squared errors which is divided by the number of observations. In a perfectly fit dataset, mean squared error should be zero. When comparing two models, the lesser value holding model can be decided as the better one.

$$MSE = \frac{1}{n}\sum_{k=1}^{n}(y_k - \hat{y}_k)^2 \qquad \text{Eqn.3.2}$$

Mean Absolute Percent Error (MAPE):

Mean absolute percentage error (MAPE) is calculated by taking absolute value of percent errors and dividing it into number of observations. Like MSE, the lesser value holding model can be decided as the better one. It can be formulated as below:

$$MAPE = \frac{1}{n}\sum_{k=1}^{n}\left(\frac{y_k - \hat{y}_k}{y_k}\right)^2 \qquad \text{Eqn.3.3}$$

Other Methods:

In literature there are many methods in use such as Mean Absolute Error (MAE), Median Absolute Percentage Error (MdAPE), Median Squared Error (MdSE), Theil’s U Statistic and so. In this study these methods will not be used.

CHAPTER 4

VARIABLE SELECTION & DATA COLLECTION

As it was mentioned before in Chapter 2, *dependent variable* means the resultant variable and *independent variables* mean helping variables which are used for estimating dependent variable. The dependent variable to be estimated in this study is the number of the passengers' data that would be used for the design and investment of a particular planned airport. (Number of passengers is sometimes credited as the acronym PAX.)

In this study *total* number of passengers was investigated and domestic/international separation was neglected. The reason behind this negligence is lack of direct scheduled international flights to Anatolian Cities. Almost all airline companies make their flights to 3 big cities and then passengers make additional transit flights to reach their destination cities. Only a few exceptional Anatolian cities have scheduled direct international flights. Passenger numbers data was obtained from DHMI statistical yearbooks and it can be found in Appendix A . The independent variables are studied in the following section:

4.1 Indicators Effecting Air Travel Demand:

When the relationship between effecting and effected variables is unclear, forecasters may tend to put too many variables that may have major or minor impact on result and pick important variables from the list by interpreting statistical analysis. This may be the case when the forecast problem is affected by highly social determinants, such as marketing problems or when there is only limited data available such as predicting origin and destination of goods and passengers in a very large area. But in this study, major indicators that examined showed good forecasting performance during preliminary studies, thus it was found unnecessary to put too many variables in a pool and detect important ones. The selected major indicators to be considered in this study are listed below. The details of the indicators can be found in the following sections of this chapter.

- Population: Almost all studies in literature investigated population as an indicator.
- Urban Population: No such indicator found in the literature regarding air transportation.
- Gravity Coefficient: No such indicator found in the literature regarding air transportation.
- Highway vs. Air Travel Duration: Rengaraju and Arasan (2001) used this indicator.
- Socioeconomic Regions: No such indicator found in the literature regarding air transportation. Socioeconomics of the communities were studied by Rengaraju and Arasan (2001) and Abbas (2006) but any indicator referring to regions was not found.
- Geographic Regions: Rengaraju and Arasan (2001) used a similar but simpler dummy variable which focuses only proximity to big cities.
- Aviation Taxes: This indicator is a unique indicator for just Turkey. Alekseev and Seixas (2009) studied similar econometric indicators unique to Brazil.
- Airliner Profitability: Alekseev and Seixas (2009) studied effect of air ticket prices.
- Air Ticket Prices: Alekseev and Seixas (2009) studied effect of air ticket prices.
- GDP and GDPPC: Almost all studies investigated gross domestic product as an indicator.
- Export Amount: Ba-Fail (2004) studied import amount of Saudi Arabia.
- Number of Export Companies: No such indicator found in the literature regarding air transportation.
- Birth Rate: No such indicator found in the literature regarding air transportation.
- Number of students: Abbas (2006) mentioned effect of the number of students to demand of air transportation in a community.
- Number of civil servants: Abbas (2006) and Rengaraju and Arasan (2001) studied effect of labor on air travel demand.
- Car ownership: Ellsworth (2000) mentioned about car ownership index during his study about modeling Atlantic region air travel. He found this parameter unnecessary.
- Price of petroleum: Profillidis and Botzoris (2006) and Abdullah, Ba-Fail, Jasimuddin (2001) studied this parameter.
- Number of Tourists: Profillidis and Botzoris (2006) studied this parameter.
- Touristic Bed Capacity: No such indicator found in the literature regarding air transportation.

4.1.1 Social Indicators:

Some of the indicators may be considered as both social and economic indicators. In Table 4.1 considered indicators are listed. The indicators are classified under two categories, namely social indicators and economic indicators. For the sake of simplicity, such indicators are placed only under one of the categories by judging the weights of the indicators on social and economic sides. Under this section, social indicators that effect travel behavior are studied.

Table 4.1 Major Indicators Considered Effecting Air Passenger Demand

Social Indicators	Economic Indicators
Population	GDPPC
Urban Population	Export Amount
Gravity Coefficient	Air Ticket Prices
Highway vs. Air Travel Duration	Airliner Profitability
Geographic Regions	Unemployment Rate
Birth Rate	Car Ownership
Number of Students	Price of Petroleum
Number of Civil Servants	Number of Tourists
Use of Internet and Mobile Phones	# of Export Companies
	Touristic Bed Capacity
	Aviation Taxes
	Socioeconomic Regions

4.1.1.1 Population:

Population is selected as one of the key independent variables. Let's assume two identical hypothetical cities. If one of the hypothetical cities had an increase in the population, all socioeconomic dynamics of this city would be changed. There had to be new production for the babies, new housing, new schools, new investments, etc. Also there would be additional birthday parties, wedding ceremonies, funeral services and similar. All those economic and social changes and activities would result with increase in transportation. So it can be assumed that if all the other parameters remained same (ceteris paribus), more crowded communities would require more need for transportation, which yields to more need of air transportation.

Population data used in this study was collected from Turkish Statistical Institute (TUIK), and it can be found in Appendix D. There is no official data representing distribution of population over cities through 2001 and 2005. So this missing data is developed by assuming linear increase in missing years for all cities.

4.1.1.2 Urban Population:

Urbanization is one of the key socioeconomic indicators. Social and economic life in rural towns and city centers differ very much. If hypothetical identical cities from previous section are considered and assumed that one of the cities' citizens decided to move to city center from rural areas; following conditions are assumed to differ: First, shopping habits of the newcomers would change. They would have to buy from groceries more goods than they used to. Also they would have to attend city jobs rather than farms. They would have to train or get trained, or attend meetings, seminars and similar. Their children would have to get educated more in order to find better jobs in city etc. So it can be concluded that if all the other parameters remain same (ceteris paribus), more urbanized communities would need more transportation services.

Urban population data used in this study was obtained from Turkish Statistical Institute (TUIK), and the distribution can be found in Appendix E. Like general population, urban population data is missing city based distribution for years 2001 through 2006 and those missing values are developed by assuming linearity.

4.1.1.3 Gravity Coefficient:

Isaac Newton's law of gravitation is used for predicting transportation of people, money and goods for a long time. Modified gravity model suggests that more populous communities have greater interaction between them. Similarly, this model suggests that closer communities have greater interaction than communities that have distance between each other. Gravitational coefficient of gravity model can be defined as:

$$G_c = \frac{Population_1 * Population_2}{Distance_{12}^2} \qquad \text{Eqn.4.1}$$

There are various gravity model equations including ticket prices, balancing factors, coefficients, etc. In this study, unmodified version of gravitational constant is used.

As gravity model suggests, most of the air traffic in Turkey is between 3 largest cities and smaller cities, and inter-city air travel out of 3 big cities amount is negligible. Fig.4.1 shows scheduled flight routes of domestic carriers in Turkey. As it can be seen from the figure, almost every flight has a connection to one of the 3 big cities in Turkey, namely Istanbul, Izmir and Ankara. For this, gravitational coefficient in this study is computed as follows:

$$G_{ci} = \frac{Population_{Istanbul} * Population_i}{{Distance_{Istanbul-i}}^2} + \frac{Population_{Ankara} * Population_i}{{Distance_{Ankara-i}}^2} + \frac{Population_{Izmir} * Population_i}{{Distance_{Izmir-i}}^2}$$

Eqn.4.2

The distances between cities are collected as the distances of highways from the records of General Directorate of Highways (Turkish: Karayolları Genel Müdürlüğü, KGM). Highway distance data can be found in Appendix F. Gravitational coefficient defined by Eqn.4.2 is computed using available data for cities for yearly basis. In the equation, "i" subscript points to any considered observation.

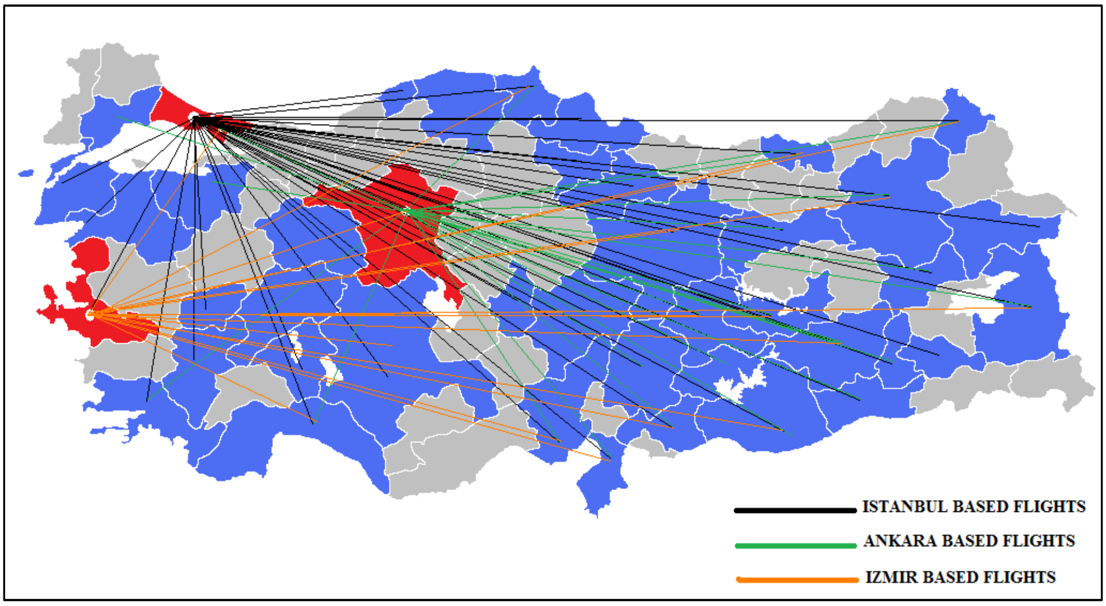

Fig.4.1 Domestic Scheduled Flights in Turkey

4.1.1.4 Highway versus Air Travel Duration:

Almost all of the cities have alternative transportation systems to air travel. Those alternatives may be roads, railways, ships, etc. In choosing transportation mode, several factors are effective, like cost, travel time, comfort, availability, safety, etc. These can be considered as the factors that highly affect the choice of passengers. Among these, travel duration can be expressed quantitatively. Highway vs. air travel duration is a coefficient which compares the highway travel and air travel by their durations. Maritime travelling is negligible in Turkey and high-speed trains are working only in limited areas as the time this thesis was studied. If these conditions change in the near future they should be included as well. Travel time estimation is easier for highways when compared to air transportation. In order to travel by car, people only need to pack their belongings and go on route. In order to determine highway travel time, the following assumptions were made:

1) Speed limit is 110 kilometers per hour in most of Turkey. Duration is computed as highway distance divided by speed limit.

2) In every 300 kilometers, a twenty minute break is given.

Travel with bus is a very common way of transportation in Turkey. There are a lot of bus companies in competition with each other and air travel companies after 2004. Bus companies provide comfortable vehicles and neat service, even some companies provide LCD display in every seat, wireless internet connection, TV-radio broadcast and gaming console. In order to compare travel methods, buses can be taken into account. Highway transportation speed limit for buses is 10% less than cars; so previous assumptions for highway travel can be kept same. Because after computing highway travel time, the coefficient will be divided to duration of air travel time and that data will be used comparing relativity between observations.

Assumptions for the air travel are a little more complex. In order to travel by air, the passengers should follow the following steps:

Step 1) Ride from home to airport

Step 2) Security checks, check in procedures

Step 3) Boarding to plane

Step 4) Flight from one point to another

Step 5) Landing of the plane, baggage claim

Step 6) Ride from airport to city

Duration for Step1, ride from home to airport, can be calculated similar to highway travel; which is duration equals to distance over average speed. Some airports in Turkey are located in city centers and some are located in distant areas. In order to calculate duration for step 1, speed limit of 50 kilometers is assumed for the inner city airports. Inner city airports can be categorized as airports which are located 0 to 10 kilometers away from city center. In order to find travel duration to distant airports, which are located more than 30 kilometers away from city centers, speed limit of 90 kilometers per hour is assumed. Although speed limit in highways is 110 kilometers per hour, some of the travel will take place in inner city areas, so reducing speed limit should be necessary. Similarly, 70 kilometers per hour speed limit is used for computing travel duration to airports that are located 10 to 30 kilometers away from city centers.

For Step2, security checks and check in procedures, average 30 minutes duration is assumed. This duration can be a little bit longer in major airports of three big cities but it is neglected.

Step 3, Boarding to plane activity includes duration of all passengers having their seats and plane leaving apron, travel taxiway and reaching to beginning of the runway. This duration is assumed as 15 minutes.

In order to find flight duration for Step 4, the average speed of the planes used in Turkey is assumed as 850 kilometers per hour. In almost every scheduled flight in Turkey, commercial jet planes are used. This average speed assumption is valid for widely used aircraft models like Boeing 737-800, 737-700, Airbus 340-311/312/313, 330-300/203, 321-231/211/232, 320, 214/232 and 319-132/100. Similar to highway travel, average distance of small cities to 3 big cities is used for calculations.

Step5. Landing of the plane and baggage claim duration is assumed 20 minutes. This duration includes aircrafts' travel from runway to aprons or gates.

Step 6, ride from airport to city, is similar to Step 1. Main difference of this step is, average distance of 3 big airports to their respective city centers is considered instead of smaller Anatolian airports. Step 6 models travel time from a 3 big city airport to a 3 big city center whereas step 1 models travel time from a small city airport to a small city center. Average air travel durations can be found in Appendix G.

4.1.1.5 Geographic Regions:

Geography has great impact on peoples' choice and need of transportation. It also affects the socioeconomic indicators of a community. Neighboring cities suffer and benefit from similar external variables such as war, climate, and economic indicators. Geographic categorization would help understanding forecasting analysis better. In 2002, Turkish Statistics Institute (TUIK) accepted a new geographical categorization system in order to integrate with European Union statistics database. In this thesis, mentioned new categorization of the cities is used which is based on 12 different regions of Turkey, as shown in Table 4.2.

It was found necessary to make a small change in order to fit a better regional classification model for this specific study. Region "TR5" was originally containing 3 Central Anatolian cities, namely: Ankara, Karaman and Konya. As it was stated earlier, Ankara is not in the focus of this study and Karaman does not have an airport. So it would be unnecessary to create a geographical category for a single city. That's why Konya was moved to adjacent region TR6. Central Anatolia. Similarly Ankara and Izmir is removed from their original categorizations and shown in TR1 regions. Original TR1 region is consist of only Istanbul. The map representing geographical regions is shown in Fig.4.2:

Table 4.2 Geographic Categorization of Turkish Cities

TR1 3B	3 BIG CITIES	**TR2 WM**	West Marmara	**TR3 AG**	Aegean	**TR4 EM**	East Marmara
	İSTANBUL		**TEKİRDAG**		**AYDIN**		**BURSA**
	ANKARA		**EDİRNE**		**DENİZLİ**		**ESKİŞEHİR**
	İZMİR		**KIRKLARELİ**		**MUĞLA**		**BİLECİK**
			BALIKESİR		**MANİSA**		**KOCAELİ**
			ÇANAKKALE		**AFYON**		**SAKARYA**
					KÜTAHYA		**DÜZCE**
					UŞAK		**BOLU**
							YALOVA
TR5 ME	Mediterranean	**TR6 CA**	Central Anatolia	**TR7 WBS**	West Black Sea	**TR8 EBS**	East Black Sea
	ANTALYA		**KONYA**		**ZONGULDAK**		**TRABZON**
	ISPARTA		**KARAMAN**		**KARABÜK**		**ORDU**
	BURDUR		**KIRIKKALE**		**BARTIN**		**GİRESUN**
	ADANA		**AKSARAY**		**KASTAMONU**		**RİZE**
	MERSİN		**NİĞDE**		**ÇANKIRI**		**ARTVİN**
	HATAY		**NEVŞEHİR**		**SİNOP**		**GÜMÜŞHANE**
	K.MARAŞ		**KIRŞEHİR**		**SAMSUN**		
	OSMANIYE		**KAYSERİ**		**TOKAT**		
			SİVAS		**ÇORUM**		
			YOZGAT		**AMASYA**		
TRA NEA TR9	Northeast Anatolia	**TRB CEA TR10**	Central east Anatolia	**TRC SEA TR11**	Southeast Anatolia		
	ERZURUM		**MALATYA**		**GAZİANTEP**		
	ERZİNCAN		**ELAZIĞ**		**ADIYAMAN**		
	BAYBURT		**BİNGÖL**		**KİLİS**		
	AĞRI		**TUNCELI**		**ŞANLIURFA**		
	KARS		**VAN**		**DİYARBAKIR**		
	IĞDIR		**MUŞ**		**MARDİN**		
	ARDAHAN		**BİTLİS**		**BATMAN**		
			HAKKARİ		**ŞIRNAK**		
					SİİRT		

4.1.2 Economic Indicators:

It is a generally accepted fact that economics and transportation are highly dependent on each other. Transportation activities are creating economical activities and economical activities are generating transportation activities. At this section solid indicators that measures economic activities are studied.

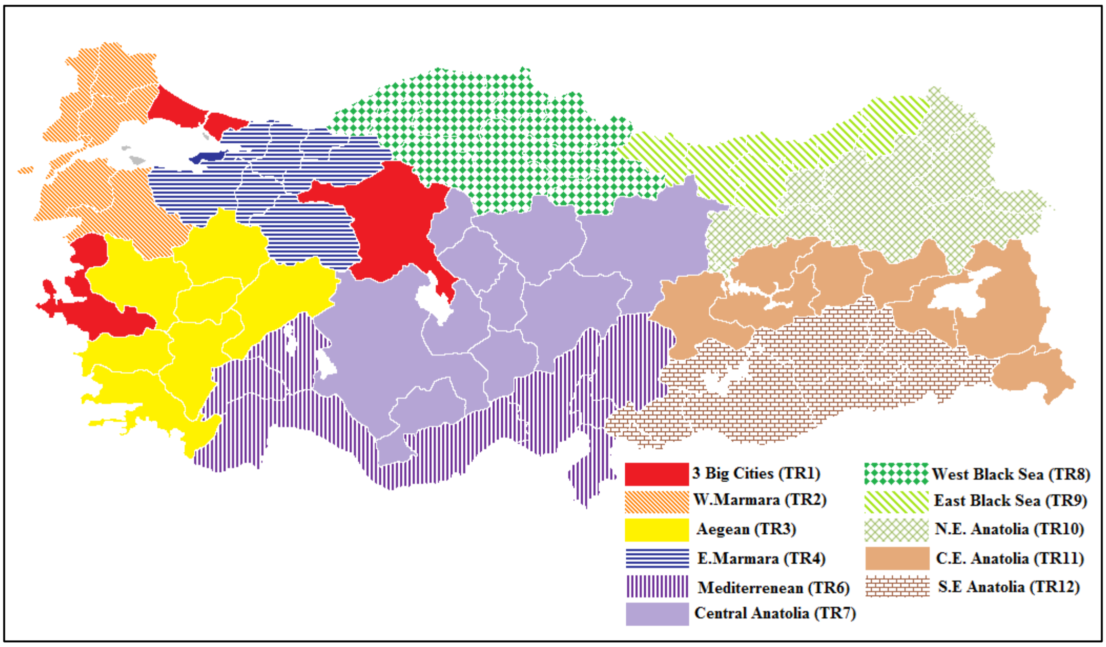

Fig.4.2 Geographical Regions of Turkey

It can be assumed that almost all social effects have economic results, but not every economic effect may have social results. In this study it is assumed that previously discussed social indicators, such as population, urban population, gravity coefficient, highway vs. air travel duration and geographic regions have major impact on both social and economical level. So these items can be categorized in economic indicators as well. But the indicators like aviation taxes, airliner profitability, GDPPC, export amount, number of export companies and touristic bed capacity have greater economic impact than their social impact thus those indicators are studied under this section.

4.1.2.1 Aviation Taxes:

Turkey is an oil-poor country and imports nearly all of the petroleum from abroad. Also there are many tax items on petroleum products but taxes were reduced from aviation fuels in 2003. Approximately 25% of airline companies' expenses are due to fuel consumption taxes (IATA, 2010). After removing special taxes from aviation fuels, registered Turkish airline companies' ticket prices started to decline. This reduction has created a great competition in the market because private airliners started to compete with state-run airliner Turkish Airlines (THY). These competition and cheaper ticket prices made a rapidly increasing impact on total traffic numbers. An increase of more than 10.000.000 passengers was utilized from years 2003 to 2004 and the increasing trend continued thereafter. This trend can be seen in the Fig.4.3.

In this study, situation of taxes is defined by a dummy variable which can be appointed as "0" meaning no taxes or "1", with taxes. Thus, the observations before 2004 were appointed as "1" and remaining appointed as "0" meaning with and without tax respectively. Dummy variables were studied in detail in Chapter 3.1.

4.1.2.2 Airliner Profitability:

In this study it is originally thought that airline ticket prices would be an effective variable for determining demand. It is obvious that if ticket prices go down, the demand will increase.

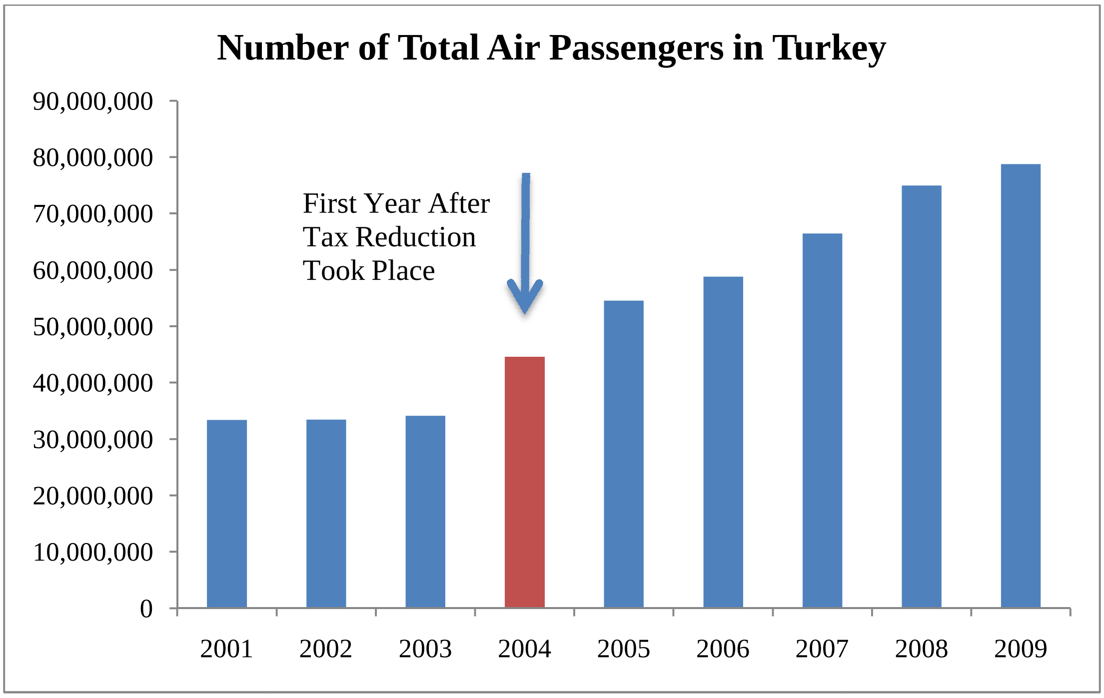

Fig.4.3 Number of Total Air Passengers in Turkey between 2001 to 2009

Unfortunately that data could not be reachable. As it was mentioned earlier Turkish Airlines (Turkish: Türk Hava Yolları, THY) is a state-run company which has %51 open shares to public as of 2010. Even though Turkish Airlines is in competition with other registered Turkish airliners (such as Pegasus, Atlas jet, etc.), it controls most of the domestic and international air traffic of Turkey. Low-cost airline equivalent of Turkish airlines is its sister company Anadolu Jet and both companies serve both on domestic and international routes.

Turkish airlines distribute annual and quarterly reports which include detailed passenger statistics and financial flows. From this reports it is possible to reach *profit per passenger* data which can be useful in two ways. First it covers macroeconomic indicators such as fuel prices, tourism attraction, economic wellness of the country, etc. Secondly airliners with good financial condition can compete better with other airliners and can provide more reasonable ticket prices in the long term. Appendix I gives the financial data of Turkish Airlines together with financial data of global equivalents. Turkish airlines' data is gathered from published records and global data is gathered from IATA, International Air Transport Association.

4.1.2.3 Gross Domestic Product per Capita (GDPPC):

Gross domestic product can be defined as the amount of goods and the services produced in borders of a country in a year. It is obvious that GDPPC for a given city will be effected by the labor supply and production possibilities and hence will indicate wealth and standards of living in the city. Additionally the level of GDPPC is a determining factor to the demand for the goods that are produced and have to be transported, personal mobility and passenger traffic. For these reasons, city vise GDPPC is considered as an importance factor for passenger traffic demand.

In this study a specific subsection of GDP, known as GDPPC was taken into account which stands for gross domestic product per capita. Unfortunately, official data of city vise distribution of GDPPC only exists between 1983 and 2001. In order to find GDPPC from 2002 to 2009, the following approach was followed:

1) Calculate cities' average GDPPC relative to the overall Turkish GDPPC in 2000 and 2001 and obtain a percentage. I.e. City of Ordu has 50% of overall Turkish GDPPC. These ratios were controlled for the years between 1983 and 2000 and it is observed that there are only minor changes in percentages.
2) Use the ratio obtained in first step to overall Turkish GDP's between 2002 and 2009.

GDPPC data is obtained from Turkish Statistical Institution (TUIK) and the prices are measured in nominal US dollars. Distribution of GDPPC can be found in Appendix J.

4.1.2.4 Socioeconomic regions:

Socioeconomic classification of the cities could provide better control over the data and help the forecaster to interpret results more effectively. Every country, even cities in the world, divided in to socioeconomic regions. Some are rich or poor, some are sea communities and some are farming, some are conservative and some communities are liberal. These communities also differ from each other historically and culturally. Those mentioned differences effect communities' needs, habits and demand of transportation. It was decided to subdivide Turkish Cities to 4 categories. Details of the categorization can be found in Appendix H.

1) 3 Big Cities (3B): These cities are the three biggest cities of Turkey; namely, Istanbul, Ankara and Izmir. The passenger profile, industry, tourism potential and other indicators of these cities are not similar to the rest of the Turkey. The population of each of these cities is over 3.000.000. These cities are not included in the panel data.

2) Anatolian Tigers (AT): "Anatolian Tigers" is a popular term referring to populous industrial cities of Turkey. This term is used by well known newspapers like Le Monde and Financial Times for describing these cities. They are not as big as 3 big cities but differ from the rest of the Turkish cities. Their populations are generally over or close to 1.000.000 and these cities make more international trade than other cities. They have bigger universities, many hospitals, well designed organized industrial infrastructure and significant industrial output. Although there is no official classification exists, these cities can be listed as Adana, Balıkesir, Bursa, Denizli, Eskişehir, Gaziantep, Kahramanmaraş, Kayseri, Konya, Samsun, Hatay and Trabzon.

3) Rural Anatolian Cities (RA): These cities are medium to small cities of Turkey. Their populations are mostly less than 1.000.000 and generally show decreasing trend because of immigration and economic issues. Most of them do not attract new and big investments. This category is divided into three subcategories:

3a) Rural Anatolia 1 (RA1): RA1 cities are closer to 3 big cities and located in the western part of Turkey. They are closer to international ports and they have better transportation infrastructure. Mostly these communities are richer than rest of the rural communities.

3b) Rural Anatolia 2 (RA2): This category is a transition category between Eastern and Western sections. These cities are closer to 3 big cities and their areas are not as mountainous as RA3 category. Economic activities in this region are more developed than RA3 but less advanced than RA1.

3c) Rural Anatolia 3 (RA3): These cities are poorest of the Rural Anatolia. They are far from 3 big cities and mostly located in eastern part of Turkey. They do not have any big industrial complexes and good transportation infrastructure. They cover mostly mountainous regions and the population is mostly farming and stockbreeding communities.

4) Tourism Cities (TC): These cities are coastal cities of Mediterranean and Aegean seas. Socioeconomic indicators of these cities are determined by tourism sector. Their airports are very large and compete with the airports of three big cities during summer season. Because of this uniqueness, they are not included in the panel data.

Fig.4.4 depicts socioeconomic regions of Turkey, as defined above:

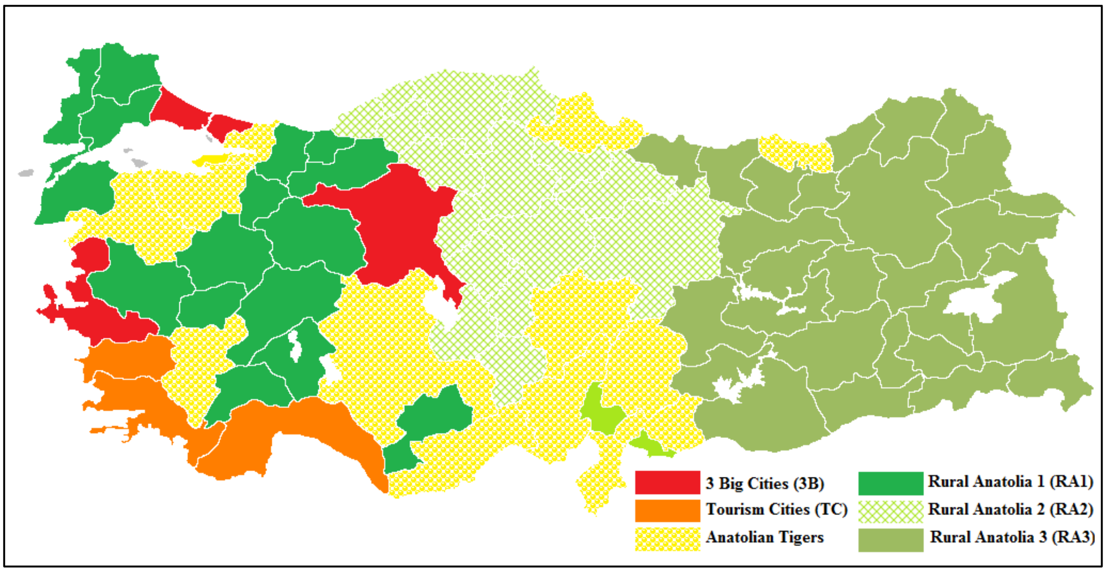

Fig.4.4 Socioeconomic Classification of Turkish Cities

In order to apply socioeconomic classifications to a mathematical model, dummy variable system is used which was described in Chapter 3. As it was mentioned earlier, statistics of 3 big cities (3B) and tourism cities (TC) were eliminated which yields to 4 categories, namely: Anatolian Tigers (AT), Rural Anatolia 1, 2 and 3 (RA1, RA2 and RA3).

4.1.2.5 Export Amount of Cities:

Exporting process requires planning, organization, communication and other activities. Naturally, communities that have international commercial relations will demand more transportation than other communities. Appendix K shows distribution of export amounts for Turkish cities in nominal US dollars obtained from Turkish Statistical Institution (TUIK).

4.1.2.6 Number of Export Companies:

In 1983, Turkish administration started to transform economic model from composite to free-market model. Use of foreign currencies were released free, most of the governmental industrial complexes were privatized and laws of international trade were eased. Especially after 2001 crisis, Turkish companies made huge improvement in their import and export operations. This situation yielded to more demand of transportation. It can be assumed that number of export making companies have impact on need of transportation. Appendix L shows number of Turkish export companies by city. Data is obtained from Turkish Statistical Institution (TUIK).

4.1.2.7 Touristic Bed Capacity:

It is a fact that tourism is one of the key reasons behind the travel demand. In order to measure tourism potential of a city, various variables can be used; such as: number of tourists, number of touristic hotels, touristic bed capacity, number of national parks, number of historical places, etc. In this study it is thought best variable representing tourism potential should be touristic bed capacity. Yearly number of tourists is not available in city vise manner and other mentioned variables such as natural and historical places, coastline etc. could be misleading. For example city of Ordu has very beautiful historical and natural places but unfortunately does not attract many tourists because of its location and climate.

Using touristic bed capacity has one more advantage, if a city makes oversupply of tourism investment, and the tourist demand does not meet the supply, than the empty beds would cause loss of money and those beds would be removed in the near future. Which means oversupply of touristic beds for many years is impossible. Sooner or later the supply will have to meet demand. This oversupply case and overall bed capacity data can be seen in tourism bed statistics in Appendix M.

4.2 Unused Data:

Some of the considered variables were not used in this study. The reasons for not using those variables are explained below:

Unemployment Rate:

As it was mentioned before, the data needed to be city vise distributed. Annual unemployment rate per city data is unavailable at the moment. Even if it was available, unemployment rate and GDPPC would be correlated and the use of unemployment would not be beneficial.

Birth Rate:

Use of birth rate may be useful when predicting future conditions of a city. But it has nothing to do with current conditions. Annual population of cities represents the effect of that rate as well.

Air Ticket Prices:

When the ticket prices go down, demand for air travel would increase. This could be a great and useful variable for the analysis but it was not possible to find that data. Instead of this, profitability of airline companies' data were found and studied.

Number of Students:

Number of university students in a city could be a useful data. But it can be very arguable that if two identical cities have same amount of population but one has more students, tend to show more demand for travel. Also at the second half of the 2000's, almost each and every city in Turkey has at least one university campus located. Students attending first, middle and high schools can be assumed homogeneously and linearly distributed per population per socioeconomic classification.

Number of Civil Servants:

This case can be considered similar to previous example of number of students and can be assumed that number is homogeneously and linearly distributed per population per socioeconomic classification.

Car ownership:

Car ownership data can be represented in GDPPC and socioeconomic classification. Richer communities would have more cars than other communities. Also highway travel versus air travel is representing this indicator. It is thought that this variable is unnecessary for this study.

Price of petroleum:

Price of petroleum effect both Turkish and global economy but in this study it is observed that demand for air travel in Turkey is immune to price of petroleum in two manners. First, there is no additional taxation to price of petroleum used in aviation. Second, total air passenger traffic showed increasing trend even when price of petroleum is over 100 $ per barrel in 2008. The effect of this indicator on economy is reflected by GDPPC and export amount. So it is decided to exclude this variable from dataset.

Number of Tourists:

Number of tourists' data could be useful but unfortunately there is no such data available in city vise distribution. It is also very difficult to gather such data because there could be many types of tourists and it would be very difficult to track them down: such as medical tourists, tourists stay in family & friends, camper tourists, tourists staying for the day, etc. So it is decided that touristic bed capacity of a city represents tourism potential better.

Use of Internet and Mobile Phones:

During initial stages of the study it is assumed that there is a link between communities' need of communication and need of transportation. We thought that a community with higher use of internet and mobile phones will tend to travel more. After negotiation with Turkish Telekom representatives it is understood that there are records of internet and phone use in city vise basis but these records were kept for only last several years and were not available for distribution for commercial reasons.

CHAPTER 5

DATA ANALYSIS

In previous chapter, important variables, data samples and collection for these variables were discussed. The next step is the testing and preparation of the data for use in forecasting process. The characteristics of the available data can be seen in Table 5.1 which shows unit, data type and source.

5.1 Data Preparation:

In general sense, forecasting can be considered as a generalization and categorization process. In this respect, in order to carry out a successful forecasting process, the data to be used in the process should be objective, correct, reliable and compatible within itself. For large datasets, it may be necessary to extract a sample set which would be easier to handle and more representative for the study targets. The sample dataset should resemble the general characteristics of the original set. Additionally the outliers, which generally can be defined as the observations that significantly differ from the study group, should be eliminated from sample dataset. General characteristics that desired for a sample dataset are studied in the following sections:

5.1.1 Objectivity of the Data:

Objectivity of the data may become important when the data cannot be presented with numbers. For example indicators like success, failure, problem, beauty and similar may differ from one person to another. In this thesis, all the indicators are based on numerical data and classifications as seen in Table 5.1.

5.1.2 Correctness of the Data:

If a source data has wrong values within, than the results of the forecasting study would be wrong too. In this study, all the necessary data was obtained from official institutions in charge.

Table 5.1 Units and Sources of the Used Data

Indicator	Unit	Data Type	Source
Population	Person	Numeric	Turkish Statistical Institution
Urban Population	Person	Numeric	Turkish Statistical Institution
Gravity Coefficient	$Person^2/kilometer^2$	Numeric	Turkish Statistical Institution , State Directorate of Highways
Highway vs. Air Travel Duration	No Unit, Ratio (minute/minute)	Numeric	State Directorate of Highways
Socioeconomic Regions	Category	Category	Self Made
Geographic Regions	Category	Category	Turkish Statistical Institution
Aviation Taxes	Yes-No Category	Binary Category	Ministry of Transportation
Airliner Profitability	USD/Person	Numeric	Turkish Airlines
GDPPC	USD/Person	Numeric	Turkish Statistical Institution
Export Amount	USD	Numeric	Turkish Statistical Institution
Number of Export Companies	USD	Numeric	Turkish Statistical Institution
Touristic Bed Capacity	Number of Beds	Numeric	Ministry of Tourism and Culture

5.1.3 Sample Set Selection:

As it was stated earlier, sample set should reflect the remaining whole data set. In order to have consistent data, the cities in Anatolia with similar sized airports are selected as representative for the conditions of case study airports. For this reason tourism cities and 3 big cities were removed from the dataset but Anatolian Tigers were kept because there are no significant differences between case study cities and them. Additionally, investigated cities may become an Anatolian Tiger city some day.

5.1.4 Outliers:

Outliers can be defined as an individual observation situated outside of the main observation set. In order to establish a good forecasting model, some outlier observations were removed from the dataset. These are explained as follows:

Cities and Airports Differing from the Rest: As it was mentioned earlier, 3 big Cities and Tourism Cities were not included in this study. Additional to those cities, city of Adana is removed from the list as well. Adana is Turkey's 4^{th} biggest city and it does not demonstrate any similarities or socioeconomic dynamics with rest of the smaller cities. That's why it is removed from the observations. Similarly, Bursa is removed from that list too. Bursa is a very large industrial city and has many alternative transportation routes and has a population above 2 million. Its socioeconomics and geography is a total outlier regarding to the remaining dataset.

Airports that Show Discontinuity in Flights: In flight data of Appendix A, it can be seen missing flights in some cities in various years. Domestic air travel in Turkey still lacks of equilibrium and probably due to economic and political reasons, some scheduled flights were cancelled then rescheduled to airports in those years. Because of this cancellation and rescheduling period, those cities' passenger data show high volatility and lack of any definite pattern. In order to prevent overall model to suffer from that volatility, only observations with 3 consecutive years were taken into account.

Airports that are not Crowded: In order to prevent volatility in data and statistical noise, idle airports are removed from the dataset. It is assumed that airports accommodating less than one scheduled flight per week can be categorized as an idle airport.

It is also assumed that a medium commercial jet with 150 passenger capacity with 70% occupancy rate is the minimum condition of a scheduled flight. That yields to 150*0.70*52 = 5460 passengers annually. An observation that has less than 5460 passengers annually was removed from this investigation.

Airports that are Statistical Outliers: Highly volatile observations may cause inconsistency in forecasting models. "In statistical sense, a value which is 3 standard deviation times above or below the mean can be defined as outlier" (Princeton University Data Center, 2007). In this study 3 standard deviations amount is used for determining outliers. As it can be seen in

Appendix A., the passenger data shows volatility. There are sudden increases and decreases in passenger numbers and some other independent variables in observations. Removing detected outliers would eliminate observations which are not complied with the rest and the remaining dataset would be more representative. As it can be seen in Table 5.2 some outliers were deleted and some outliers were kept.

Table 5.2 Outlier Observations

Observation	Outlier Variable	Result
Balıkesir-Körfez_2006	Outlier by Gravity Coefficient; Bed Capacity (upper end)	Deleted
Balıkesir-Körfez_2007	Outlier by Gravity Coefficient; Bed Capacity (upper end)	Deleted
Balıkesir-Körfez_2008	Outlier by Gravity Coefficient; Bed Capacity (upper end)	Deleted
Denizli-Çardak_2007	Outlier by Export Amount (upper end)	Deleted
Denizli-Çardak_2008	Outlier by Export Amount (upper end)	Deleted
Denizli-Çardak_2009	Outlier by Export Amount (upper end)	Deleted
GaziAntep_2006	Outlier by Export Amount (upper end)	Deleted
GaziAntep_2007	Outlier by Export Amount; #of Export Companies (upper end)	Deleted
GaziAntep_2008	Outlier by Export Amount;# of Export Companies (upper end)	Deleted
GaziAntep_2009	Outlier by Export Amount; #of Export Companies (upper end)	Deleted
Trabzon_2006	Outlier by Passenger Number (upper end)	Deleted
Trabzon_2007	Outlier by Passenger Number (upper end)	Deleted
Trabzon_2008	Outlier by Passenger Number (upper end)	Deleted
Trabzon_2009	Outlier by Passenger Number (upper end)	Deleted
Whole Konya Data	Outlier by Gravity Coefficient (but value is very close to upper limit)	Not Deleted
Whole Nevşehir Data	Outlier by Bed Capacity (but value is very close to upper limit)	Not Deleted
Konya_2009	Outlier by Export Amount (but value is very close to upper limit)	Not Deleted

The reason behind keeping those outliers is that the difference between the actual and maximum allowed upper and lower bound values (mean of all observations ± 3*standard deviations) is negligibly small. Also Konya and Nevşehir are two important cities in Central Anatolia that have unique properties and they add vital contributions to general data set since they have exceptional industrial and touristic infrastructure respectively.

5.2 Estimating Future Variables:

In this study, estimating future passenger number of Zafer and Or-Gi airports is the main goal and in order to estimate future passenger number, future socioeconomic conditions should be estimated properly. Although the established model can be used for any time span, 10 year span of the estimations are studied. Estimating socioeconomic indicators in longer time intervals can be misleading and more subjective. Additionally 10 year financial cash flow should be enough for forecasters and decision makers to decide an airport investment.

5.2.1 Population:

According to Hacettepe University, population science institute estimated 2020 populations of the cities are as follows:

Population_Kütahya_2020: 463.394
Population_Afyon_2020: 673.358
Population_Uşak_2020: 324.570

This yields to:

Population_Zafer_2_2020: 1.136.752
Population_Zafer_3_2020: 1.461.322

Here Zafer_2 is the scenario where Zafer airport would serve only Kütahya and Afyon, and Zafer_3 is the case where it would include city of Uşak as well.

Similarly populations of Ordu, Giresun and Or-Gi Airport are listed below:

Population_Ordu_2020: 708253
Population_Giresun_2020: 437327
Population_Or-Gi_2020: 1145580

5.2.2 Urban Population:

It is assumed that the ratio of urban population to population of a city in future year would be equal to the ratio of average urban population to average city population during years 2000 to 2009. It is expressed by the following equation:

$$\frac{Future\ Urban\ Population_{2020}}{Future\ Population_{2020}} = \frac{Average\ Urban\ Population_{2000-2009}}{Average\ Population_{2000-2009}} \quad \text{Eqn.5.1}$$

The assumed urban populations of 2020 can be calculated as follows:

Urban_Population_Kütahya_2020: 256.900

Urban_Population_Afyon_2020: 327.638

Urban_Population_Uşak_2020: 200.563

This yields to:

Urban_Population_Zafer_2_2020: 584.538

Urban_Population_Zafer_3_2020: 785.101

Similarly:

Urban_Population_Ordu_2020: 363.416

Urban_Population_Giresun_2020: 335.423

Urban_Population_Or-Gi_2020: 698.839

5.2.3 GDPPC:

The latest record, for 2009, nominal GDPPC in Turkey was 8.248 USD. According to Deutsche Bank and Goldman Sachs reports, GDPPC of Turkey will be between 11.000-14.000 nominal USD in 2020. According to State Planning Institute (DPT in Turkish acronym), it will be around nominal 20.000 USD. For this study it is assumed that Turkish GDPPC will be 15.000 USD in 2020. According to this assumption, GDPPC of the cities and the respective airports are listed below. Transition from Turkey's GDP to city vise distribution is studied in Chapter 4. GDPPC of the cities served by the planned airports were computed according to proportion of the cities respective populations and GDPPC values which is defined in Eqn.5.2.

GDPPC of the served region =

*Population1*GDPPC1+Population2*GDPPC2)/(Population1+Population2).* Eqn.5.2

GDPPC_Kütahya_2020: 12.097 USD

GDPPC_Afyon_2020: 8.824 USD

GDPPC_Uşak_2020: 10.274 USD

which makes Zafer airport values as:

GDPPC_Zafer2_2020: 10.158 USD

GDPPC_Zafer3_2020: 10.184 USD

City of Ordu, Giresun and Or-Gi Airport Values are listed as below:

GDPPC_Ordu_2020: 7.246 USD

GDPPC_Giresun_2020: 7.317 USD

GDPPC_Or-Gi_2020: 7.273 USD

5.2.4 Gravity Coefficient:

Future Gravity Coefficient is computed using future population data of 3 big cities and cities of Ordu, Giresun, Afyon, Kütahya and Uşak. For the gravity coefficients of the planned airports, averages of populations of the cities to be served were used.

5.2.5 Airliner Profitability:

It is very difficult to predict airliner profitability for the future. During the last ten years, the profitability showed great volatility. It is assumed that the average of profitability in last 3 years will remain constant which is computed as 50 USD per passenger in Appendix I.

5.2.6 Travel Duration Comparison (Highway vs. Air Travel Duration):

The planned location of Zafer airport will be 57 kilometers away from Afyon, 80 kilometers away from Uşak and 50 kilometers away from Kütahya. Or-Gi airport will be 25 kilometers far from Giresun and 19 kilometers far from Ordu.

This situation yield that Zafer airport's distance to 3 Big Cities is 390 kilometers and distance of Or-Gi Airport is 890 kilometers. From Appendix I, it can be seen that Highway vs. Air Travel Duration ratio is 1.10 for Zafer Airport and 2.89 for Or-Gi Airport.

5.2.7 Aviation Taxes:

It is assumed that current situation with aviation tax support will continue and there would not be future changes in tax policy.

5.2.8 Export Amount:

Export amounts of cities and their trends are provided in Fig.5.1. It is observed that except city of Ordu, other cities showed increasing trends in export amounts.

It is decided to represent the export amounts by linear best fit lines. Linear regression equations, R^2 values and resulting estimated values for 2020 are presented in Table 5.3, "X" value in the table refers to year variable.

5.2.9 Export Companies:

Similar to previous section about export amounts of cities, linear regression was used to predict future number of export companies. Fig.5.2 shows number of export making companies. Regression equations and estimated results for 2020 were given in Table 5.4, "X" value in the table refers to year variable. The data of City of Ordu was too volatile and it was not suitable for polynomial or linear regression. It is assumed that there would not be any increasing or decreasing trend on the number of export companies in Ordu.

5.2.10 Bed Capacity:

Fig.5.3 depicts the bed capacities of cities between 2000 and 2009. Similar to other predictions in this section, simple linear regression is used. In order to find future predictions, regression equations applied. Equations and outcomes were given in Table 5.5, “X” value in the table refers to year variable.

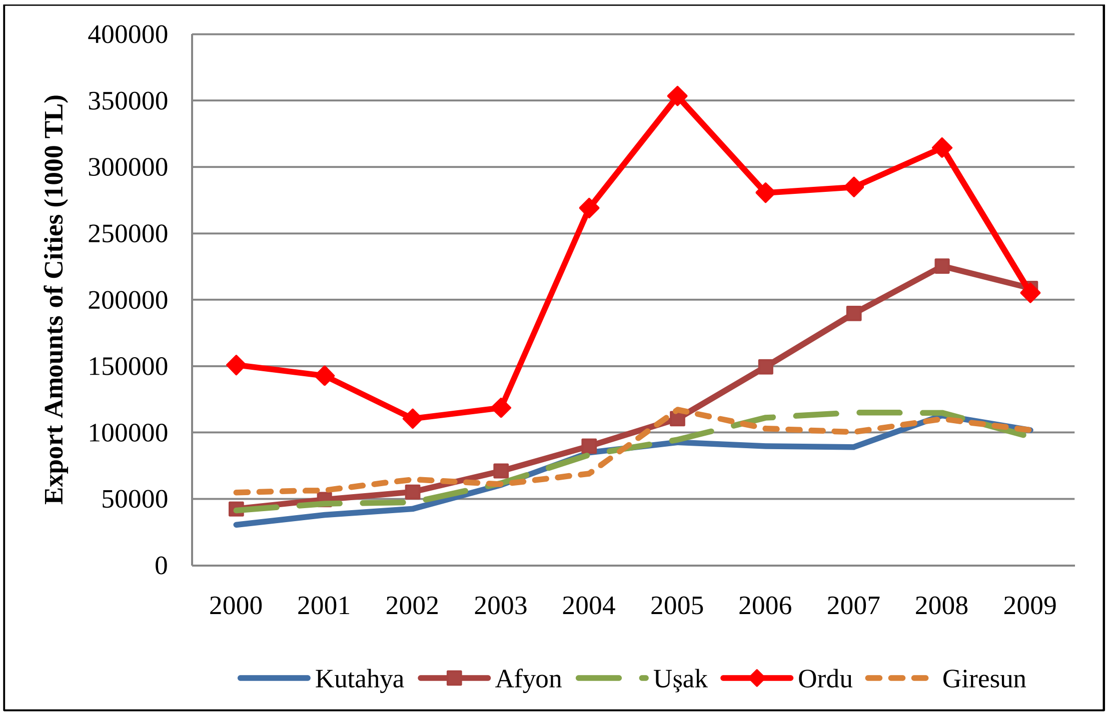

Fig.5.1 Export Amounts of Cities between 2000 to 2009 (in 1000 Nominal Turkish Liras)

Table 5.3 Estimations of Export Amounts for 2020

City	Regression Equation	R^2 Value	Estimated Export Amount for 2020 (1000 Liras)
Kütahya	Y=9058.5X+24453	0.8917	19,654.50
Afyon	Y=22146X-2645.3	0.9357	418,128.70
Uşak	Y=8946.9X+32000	0.8327	201,993.00
Ordu	Y=18984X+118590	0.4241	479,286.00
Giresun	Y=6969.9X+45522	0.7343	177,950.10
Zafer_2			614,693
Zafer_3			816,686
Or-Gi			657,236.10

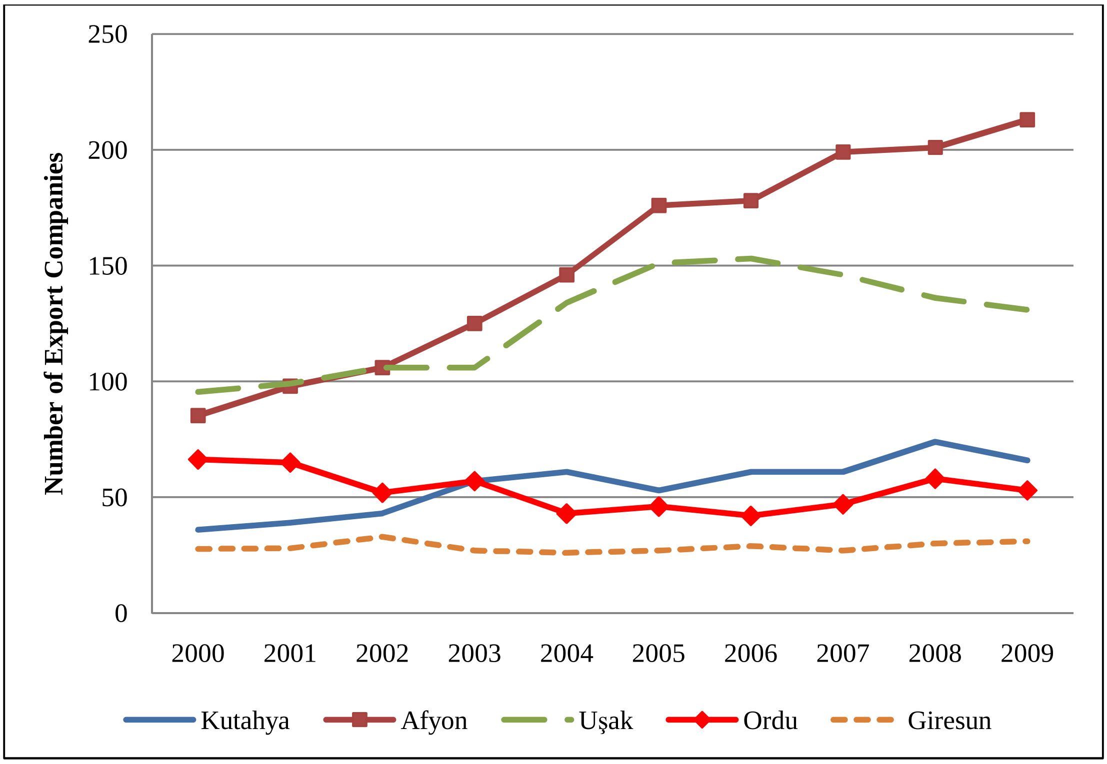

Fig.5.2 Number of Export Companies of cities between 2000 to 2009

Table 5.4 Estimations of Number of Export Companies for 2020

City	Regression Equation	R^2 Value	Estimated Number of Export Making Companies for 2020
Kütahya	Y=3.6090X+34.8	0.8271	105
Afyon	Y=15.303X+68.556	0.9741	359
Uşak	Y=5.6788X+94.511	0.604	202
Ordu			53
Giresun	Y=0.1273X+27.867	0.0312	30
Zafer_2			464
Zafer_3			666
Or-Gi			83

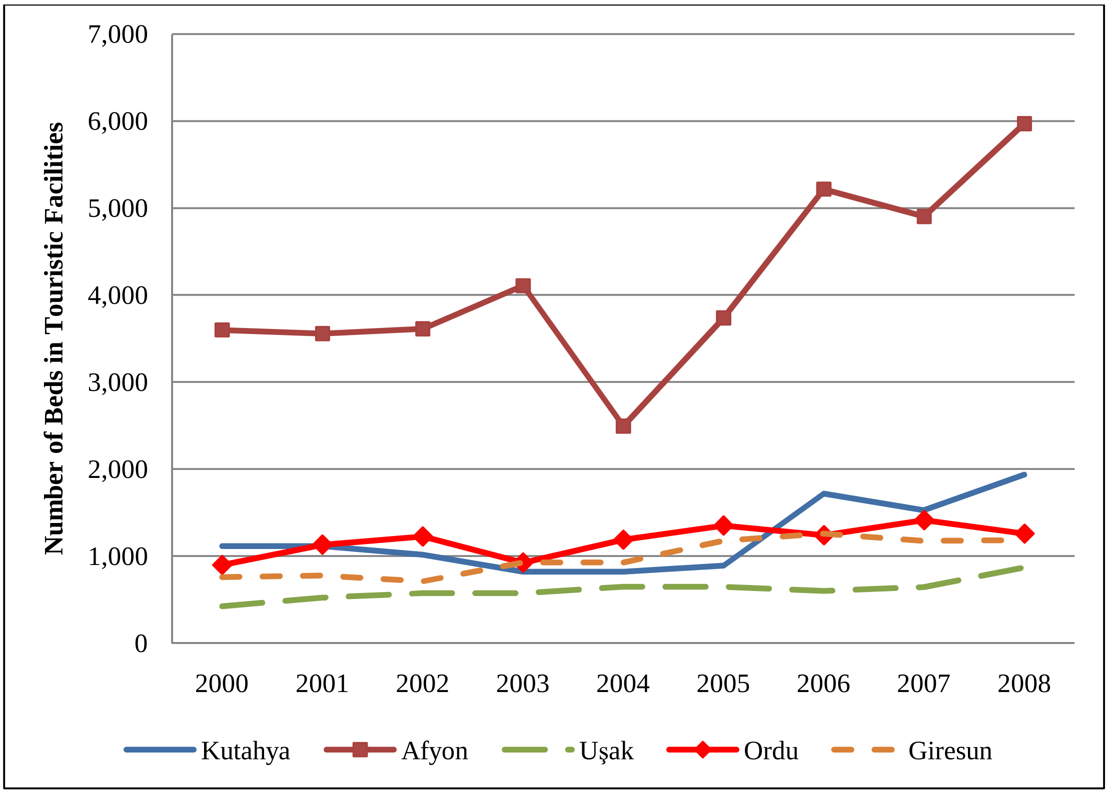

Fig.5.3 Number of Beds in Touristic Facilities in Cities

Table 5.5 Estimations of Number of Beds in Touristic Facilities in Cities for 2020

City	Regression Equation	R2 Value	Estimated Bed Capacities for 2020
Kütahya	Y=99.667X+719.44	0.4448	2,610
Afyon	Y=272.57X+2770.3	0.5027	7,950
Uşak	Y=37.867X+422	0.7416	1,141
Ordu	Y=45.633X+952.28	0.515	1,819
Giresun	Y=70.967X+633	0.8242	1,981
Zafer_2			10,560
Zafer_3			11,701
Or-Gi			3,800

5.3 Regression Analysis with the Data:

5.3.1 Need of Transformation of the Data:

As it was mentioned in the previous section, forecasting method and the data should be compatible with each other.

Outliers in the data were removed in the previous section. But in order to establish a successful regression model the following specifications (recalled from Chapter 3.1) with the data should be acquired:

1) Data should be homoscedastic.

2) Distribution of the data should demonstrate normal distribution.

3) Linearity should be accomplished within dependent and independent variables.

4) Multicollinearity should be eliminated.

If the data does not show listed properties, it is always possible to transform the data in order to fit. Most common transformations are logarithmic transformation, square root transformation and Box-Cox transformation. As the name suggests logarithmic transformation refers to applying logarithm or natural logarithm functions to independent and/or dependent variables. Square root transformation refers to applying square root function to variables and Box-Cox transformation is a method similar to logarithmic transformation.

When final data (Appendix N) was investigated, it is observed that it is heteroscedastic, out of symmetric patterns and have mostly non-normal distribution

When regression analysis is applied on sample data without any transformation, the illogical results like negative passenger numbers are observed. In order to prevent this situation, it is decided that transformation of the data is necessary. The effect of transformation can be seen by comparing Fig.5.4 and Fig.5.5. After natural logarithm function is applied to the population data, the scatter plot became more homoscedastic, more homogeneously distributed and showed stronger linear cause and effect behavior.

The R^2 values also indicate that linearity of the transformed data is higher since Fig 5.1 has 18% fit and Fig 5.2 has 30% fit. The greater fit to scatter plot means, more linearity, which leads to linear distribution between variances, which leads to more homoscedasticity and more normally distributed data. Table 5.6 compares R2 values of alternative transformation functions.

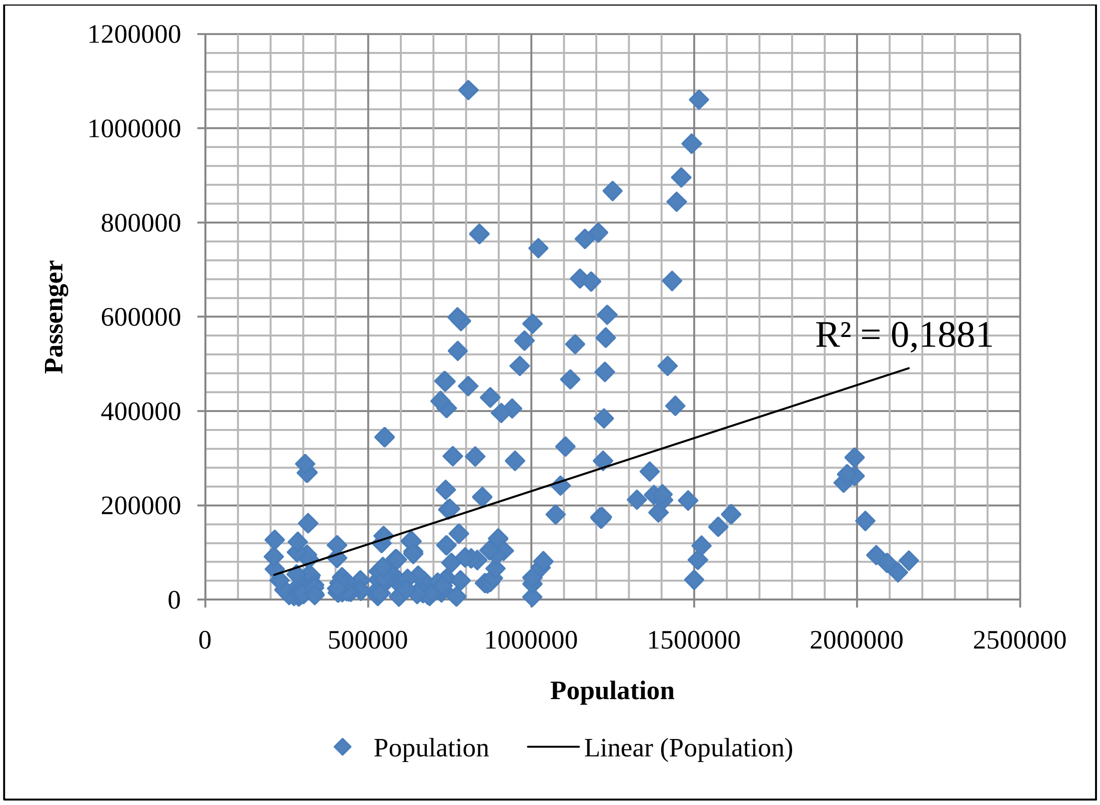

Fig.5.4 Scatter Plot Distribution of Population vs. Passenger Data

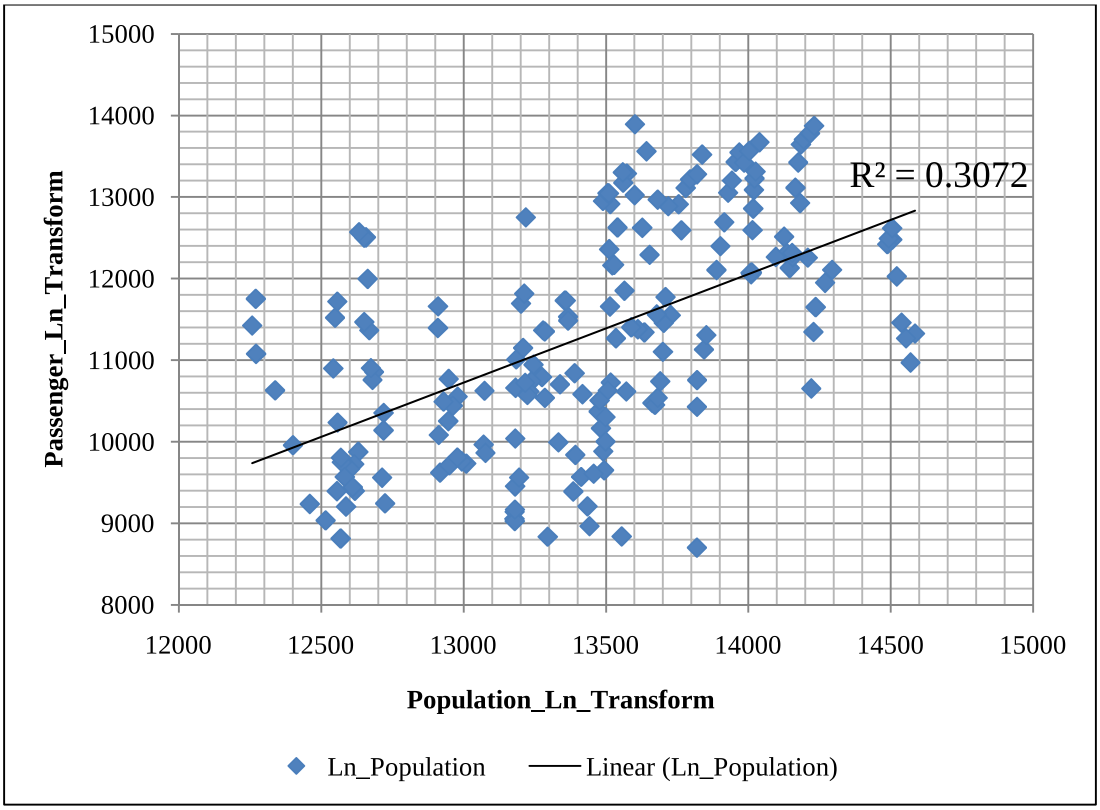

Fig.5.5 Scatter Plot Distribution of Population vs. Passenger Data after Ln Transformation on Both Variables

In Table 5.6, maximum values are highlighted and these values suggest that natural logarithm transformation of dependent variable is necessary, since 6 of 8 variables result with higher R^2 values when this transformation is applied to it. In independent variable section of the table, except urban population value, all other independent variables point to logarithmic transformation as well.

Table 5.6 R^2 Values After Data Transformation

		R^2 Values For Passenger Data		
INDEPENDENT VARIABLES AND TRANSFORMATION TYPES		Without Transform.	With LN Transform.	With Square Root Transform.
POPULATION	Population	0.1881	0.2789	0.2469
	Ln_Population	0.221	0.3072	0.2814
	Sqrt_Population	0.2139	0.3054	0.2758
URBAN POPULATION	Urban Population	0.1898	0.2741	0.2468
	Ln_Urban Population	0.2133	0.2898	0.2694
	Sqrt_Urban Population	0.2131	0.2978	0.2726
GDPPC	GDPPC	0.0118	0.0043	0.0076
	Ln_GDPPC	0.0389	0.0324	0.0368
	Sqrt_GDPPC	0.0246	0.0153	0.0202
Gravity Coefficient	Gravity Coefficient	0.0025	0.019	0.0083
	Ln_Gravity Coefficient	0.024	0.045	0.035
	Sqrt_Gravity Coefficient	0.0097	0.0301	0.0184
Highway vs. Air Travel Duration	Highway vs. Air Travel Duration	0.045	0.0294	0.0422
	Ln_Highway vs. Air Travel Duration	0.0508	0.0371	0.035
	Sqrt_Highway vs. Air Travel Duration	0.048	0.0333	0.0463
Export Amount	Export Amount	0.0633	0.0758	0.074
	Ln_Export Amount	0.0859	0.1228	0.1087
	Sqrt_Export Amount	0.0838	0.1042	0.0996
Number of Export Companies	Number of Export Companies	0.0055	0.0044	0.0061
	Ln_Number of Export Companies	0.078	0.1126	0.1015
	Sqrt_Number of Export Companies	0.0601	0.1019	0.0858
Bed Capacity	Bed Capacity	0.0013	0.0036	0.002
	Ln_Bed Capacity	0.0573	0.0983	0.0797
	Sqrt_Bed Capacity	0.0198	0.0355	0.0276

In order to keep model in the same transformation system, natural logarithm transformation was applied to all variables. Square root transformation is totally disregarded since natural logarithm transformation performs better in most of the independent variables in the table. Categorical variables and airliner profitability are exceptions and they are not transformed since profitability holds negative values and logarithmic transformation for 0-1 values would be impossible.

5.3.2 Applying Regression Analysis:

The data in Appendix N was the final form of the data which was free from outliers and unwanted variables. After applying transformation according to previous section and adding estimated future variables to SPSS 17.0 software, building up the regression model started. First step of the model was detecting statistically significant variables and the second step was to minimize the correlations between these variables.

The whole data in Appendix N is loaded except dummy variables of RA1 and C3. Removal of these dummy variables is a necessity and a common method in order to avoid full correlation. The details of use of dummy variables can be found in Chapter 3.

5.3.2.1 Detecting Statistically Significant Variables:

In Chapter 3.1 Regression analysis, α value which refers to statistical significance was discussed. There is no strict rule for selecting statistical confidence level of α value but $\alpha \leq 0.05$ is a commonly accepted minimum value and the acceptable range is considered as $0.05 \leq \alpha \leq 0.10$.

Trial #1: After loading the data, the following results were obtained.

Table 5.7 Model Summary and Analysis of Variance Chart for Regression Trial #1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.858	.737	.702	745.934

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.587E8	22	1.176E7	21.131	.000
	Residual	9.237E7	166	556417.300		
	Total	3.510E8	188			

R Square value stands at 0.737 in Table 5.7. which is a quite acceptable value. In Table 5.8, "b11" refers to socioeconomic and "b12" refers to geographic categorization variables. The details of socioeconomic classification of Turkish cities can be found in Appendix H and geographical classification can be found in Table 4.2.

Table 5.8 Coefficients of Regression Trial #1

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-13173.950	4684.027		-2.813	.006
	b11_Anatolian_Tigers	863.846	431.400	.281	2.002	.047
	b11_RA1	1413.870	682.994	.319	2.070	.040
	b11_RA2	-926.451	496.411	-.200	-1.866	.064
	b12_2	-2055.166	757.013	-.368	-2.715	.007
	b12_3	218.000	645.072	.036	.338	.736
	b12_4	-734.056	701.482	-.067	-1.046	.297
	b12_5	-1363.239	554.290	-.213	-2.459	.015
	b12_6	930.621	475.843	.259	1.956	.052
	b12_7	1226.466	540.271	.219	2.270	.024
	b12_8	803.965	565.632	.095	1.421	.157
	b12_9	301.142	235.084	.087	1.281	.202
	b12_10	866.030	200.054	.238	4.329	.000
	b5 Airliner Profit	9.450	4.258	.160	2.219	.028
	b7 Aviation Tax	193.613	238.994	.063	.810	.419
	Ln_b1_Population	1.046	.872	.436	1.199	.232
	Ln_b2_Urban_Population	.597	.772	.297	.773	.441
	Ln_b3_GDPPC	.883	.321	.394	2.751	.007
	Ln_b4_Gravity_Coef	-.667	.231	-.539	-2.883	.004
	Ln_b6_Highway_vs_Air	.859	.526	.211	1.635	.104
	Ln_b8_Export	.161	.082	.292	1.964	.051
	Ln_b9_Export_Companies	-.449	.184	-.507	-2.445	.016
	Ln_b10_Bed_Capacity	.687	.115	.447	5.991	.000

In Table 5.8, it is observed that urban population has the highest α value, which is 0.441 and should be eliminated in the following trial. Although some of the dummy variables have low statistical significance, it is decided best to keep them. The reasons behind keeping them are: 1) Statistical significant coefficients may be significant due to their high number of observations.

2) Second, removing some categories may lead many observations to non-existent categories which would model random regions in Turkey.

In order to keep categories intact, observations in the non-significant categories should have been removed and that would decrease the overall performance of the model. This decrease in performance was witnessed during preliminary studies of the data. Also during correlation checks it is observed that dummy variables are not highly correlated with other variables. So it is decided to keep them as they are.

Trial #2: After removing urban population, the following results were received.

Table 5.9 Model Summary and Analysis of Variance Chart for Regression Trial #2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.858	.736	.703	745.035

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.583E8	21	1.230E7	22.162	.000
	Residual	9.270E7	167	555076.477		
	Total	3.510E8	188			

Table 5.10 Coefficients of Regression Trial #2

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-15598.599	3474.614		-4.489	.000
	b11_Anatolian_Tigers	914.755	425.829	.298	2.148	.033
	b11_RA1	1687.729	583.227	.381	2.894	.004
	b11_RA2	-818.449	475.770	-.176	-1.720	.087
	b12_2	-2406.102	605.054	-.431	-3.977	.000

Table 5.10 Continued

	b12_3	-36.926	553.738	-.006	-.067	.947
	b12_4	-724.666	700.531	-.066	-1.034	.302
	b12_5	-1576.077	480.493	-.246	-3.280	.001
	b12_6	828.981	456.766	.231	1.815	.071
	b12_7	1044.248	485.550	.187	2.151	.033
	b12_8	602.514	501.418	.071	1.202	.231
	b12_9	359.933	222.174	.104	1.620	.107
	b12_10	851.364	198.913	.234	4.280	.000
	b5_Airliner_Profit	7.954	3.788	.134	2.100	.037
	b7_Aviation_Tax	287.091	205.896	.094	1.394	.165
	Ln_b1_Population	1.680	.295	.700	5.689	.000
	Ln_b3_GDPPC	1.050	.237	.468	4.423	.000
	Ln_b4_Gravity_Coef	-.649	.230	-.524	-2.823	.005
	Ln_b6_Highway_vs_Air	.946	.513	.232	1.844	.067
	Ln_b8_Export	.167	.081	.304	2.059	.041
	Ln_b9_Export_Companies	-.408	.176	-.461	-2.324	.021
	Ln_b10_Bed_Capacity	.635	.093	.413	6.831	.000

In trial #2, it is seen that aviation taxes indicator is not statistically significant for the model. Removal of the urban population from previous trial did not affect overall R^2 value, as expected. There had been only a slight fall from 0.737 to 0.736. It is observed that in Trial #2, aviation tax became the least statistically significant independent variable.

Trial #3: After removing aviation tax from the dataset, the following results were obtained:

Table 5.11 Model Summary and Analysis of Variance Chart for Regression Trial #3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.856	.733	.701	747.125

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.573E8	20	1.286E7	23.044	.000
	Residual	9.378E7	168	558196.175		
	Total	3.510E8	188			

It is observed that R^2 value was slightly decreased from 0.736 to 0.733. Also in table 5.12 statistically significant values and their α values can be seen. Highway vs. air travel Duration has α value of 0.078 but it was kept since it is between 0.05 and 0.10. It is understood that urban population and aviation taxes have no statistical significance for this model.

Table 5.12 Coefficients of Regression Trial #3

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-13784.396	3230.851		-4.266	.000
	b11_Anatolian_Tigers	942.831	426.547	.307	2.210	.028
	b11_RA1	1649.331	584.212	.372	2.823	.005
	b11_RA2	-799.589	476.912	-.172	-1.677	.095
	b12_2	-2295.714	601.535	-.411	-3.816	.000
	b12_3	-107.914	552.940	-.018	-.195	.845
	b12_4	-744.496	702.352	-.068	-1.060	.291
	b12_5	-1588.625	481.756	-.248	-3.298	.001
	b12_6	778.552	456.609	.217	1.705	.090
	b12_7	1033.393	486.850	.185	2.123	.035
	b12_8	614.039	502.757	.072	1.221	.224
	b12_9	329.834	221.743	.095	1.487	.139
	b12_10	857.476	199.423	.236	4.300	.000
	b5_Airliner_Profit	7.488	3.784	.127	1.979	.049
	Ln_b1_Population	1.607	.291	.670	5.514	.000
	Ln_b3_GDPPC	.850	.190	.379	4.482	.000
	Ln_b4_Gravity_Coef	-.603	.228	-.488	-2.645	.009
	Ln_b6_Highway_vs_Air	.910	.514	.223	1.771	.078
	Ln_b8_Export	.171	.082	.309	2.092	.038
	Ln_b9_Export_Companies	-.400	.176	-.452	-2.275	.024
	Ln_b10_Bed_Capacity	.652	.092	.424	7.048	.000

Trial #3 is the final trial and the coefficients in Table 5.12 will be used for determining multicollinearity. In order to understand effects of variables in model, remaining independent variables were removed from the model and their significance on R^2 was observed. The results are presented in Table 5.13, where it is observed that most important variable in the model is geographic regions. Without all other independent variables, Geographic regions have over 20% impact on R^2. Geographic regions are followed by GDPPC and socioeconomic regions as both of these variables have 15.8% impact on R^2 separately. After those, population variable comes as one of the most important indicator which has 11.2% impact on R^2 value. Remaining variables have less than 5% impact.

Table 5.13 Impact of Independent Variables on Regression Model

Removed Independent Variable	R^2 Value	Change in R^2 Value
None	0.737	-
Urban Population	0.736	-0.001
Aviation Tax	0.733	-0.003
Highway vs. Air Travel	0.728	-0.004
Airliner Profit	0.720	-0.008
Export Amount	0.710	-0.010
Number of Export Companies	0.706	-0.04
Gravity Coefficient	0.674	-0.032
Bed Capacity	0.633	-0.041
GDPPC	0.475	-0.158
Population	0.363	-0.112
Socioeconomic Regions	0.205	-0.158
Geographic Regions	0	-0.205

5.3.2.2 Detecting Multi-Collinearity:

In Chapter 3.1, collinearity issue was discussed in detail and it was underlined that it is important to detect and fix collinearities in regression models. After running collinearity analysis with independent variables in Table 5.13, the following collinearities found:

Table 5.14 Collinear Variables in Regression Model

	Ln_b4_Gravity_Coef	Ln_b6_Highway_vs_Air	Ln_b8_Export	Ln_b9_Export_Companies
Ln_b4_Gravity_Coef		-0.76		0.81
Ln_b8_Export				0.92
Ln_b9_Export_Companies	0.81		0.92	

The collinearity table with all variables listed in detail can be found in Appendix O. It is observed that there is no collinearity of dummy variables. From Table 5.14, it is concluded that removal of the gravity coefficient from the regression model would eliminate collinearities. Correlation between export and export making companies is interesting because eliminating of either makes other one statistically insignificant but both have influence on the overall model. Removing the both values cause R^2 to fall only by 1%. So it was decided to remove both of them from the model since their impact on the model is negligible.

5.3.2.3 Final Model:

After removal of insignificant variables, the final model is formed in Table 5.15:

Table 5.15 Model Summary and Analysis of Variance Chart for Final Model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.845	.715	.686	765.387

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.509E8	17	1.476E7	25.190	.000
	Residual	1.002E8	171	585817.455		
	Total	3.510E8	188			

Table 5.16 Regression Coefficients of the Final Model

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-13158.738	2443.391		-5.385	.000
	b11_Anatolian_Tigers	-366.918	395.981	-.120	-.927	.355
	b11_RA2	-1691.277	444.623	-.364	-3.804	.000
	b12_RA3	-830.549	533.185	-.304	-1.558	.121
	b12_2	-1245.780	436.620	-.223	-2.853	.005
	b12_4	-1004.098	538.869	-.092	-1.863	.064

Table 5.16 Continued

b12_5	-1062.996	424.338	-.166	-2.505	.013
b12_6	569.092	383.842	.159	1.483	.140
b12_7	1213.378	423.815	.217	2.863	.005
b12_8	1421.194	592.629	.167	2.398	.018
b12_9	690.935	599.447	.199	1.153	.251
b12_10	1175.934	565.331	.324	2.080	.039
b12_11	403.146	548.235	.117	.735	.463
b5_Airliner_Profit	7.748	3.869	.131	2.003	.047
Ln_b1_Population	.886	.162	.369	5.476	.000
Ln_b3_GDPPC	.784	.173	.349	4.530	.000
Ln_b6_Highway_vs_Air	1.771	.439	.435	4.032	.000
Ln_b10_Bed_Capacity	.578	.091	.376	6.327	.000

Regression equation of the final model can be written like this:

$$Ln(Number\ of\ Air\ Passengers)$$
$$= -13158 + 7.748 * Airliner\ Profit + 0.886 * Ln(Population)$$
$$+ 0.784 * Ln(GDPPC) + 1.771 * Ln(Highway\ vs. Air\ Travel\ Duration)$$
$$+ 0.578 * Ln(Bed\ Capacity) + Socioeconomic\ Category\ Effect$$
$$+ Geographic\ Category\ Effect$$

Eqn.5.3

In a well distributed successful linear regression model, distribution of residuals is expected to follow a normal distribution. In this case, residuals tend to follow a normal distribution curve which is depicted in Fig. 5.6.

Fig.5.7 shows a scatter plot which shows standardized residuals against standardized predicted values. In a regression model which has strong linear relationships and strong homoscedasticity, this graph should be both oval and carry same width for all values of the predicted dependent variable. Fig.5.7 shows neither property exactly but it is much better than the scatter plot of the untransformed regression model which is given in Fig.5.8. It was provided for comparison purposes only.

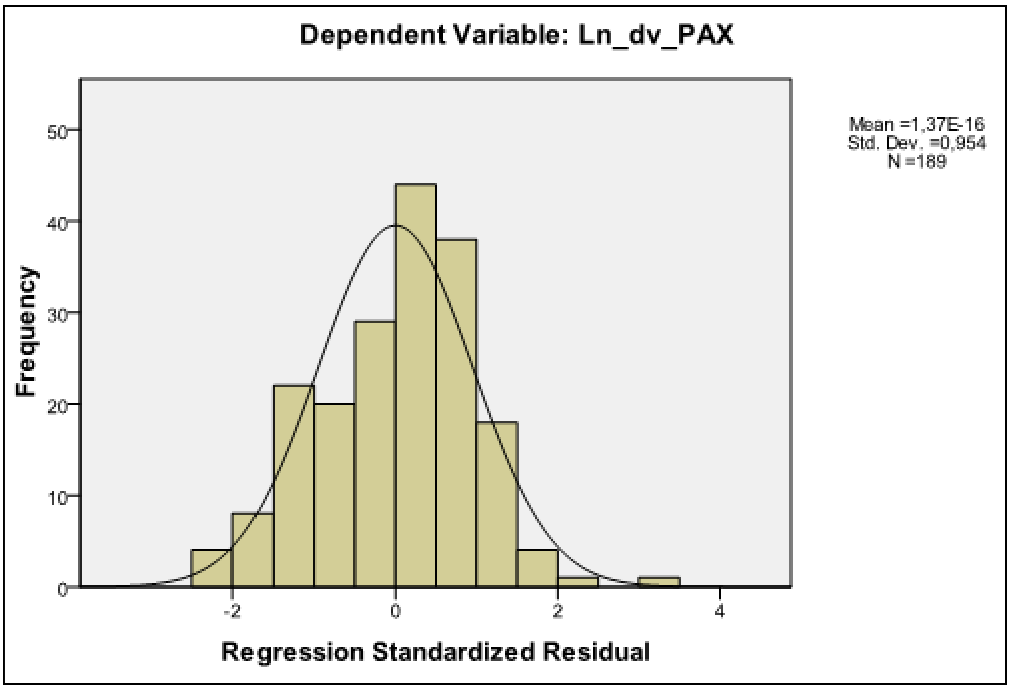

Fig 5.6 Normal Distribution of Standardized Residuals for Regression Model

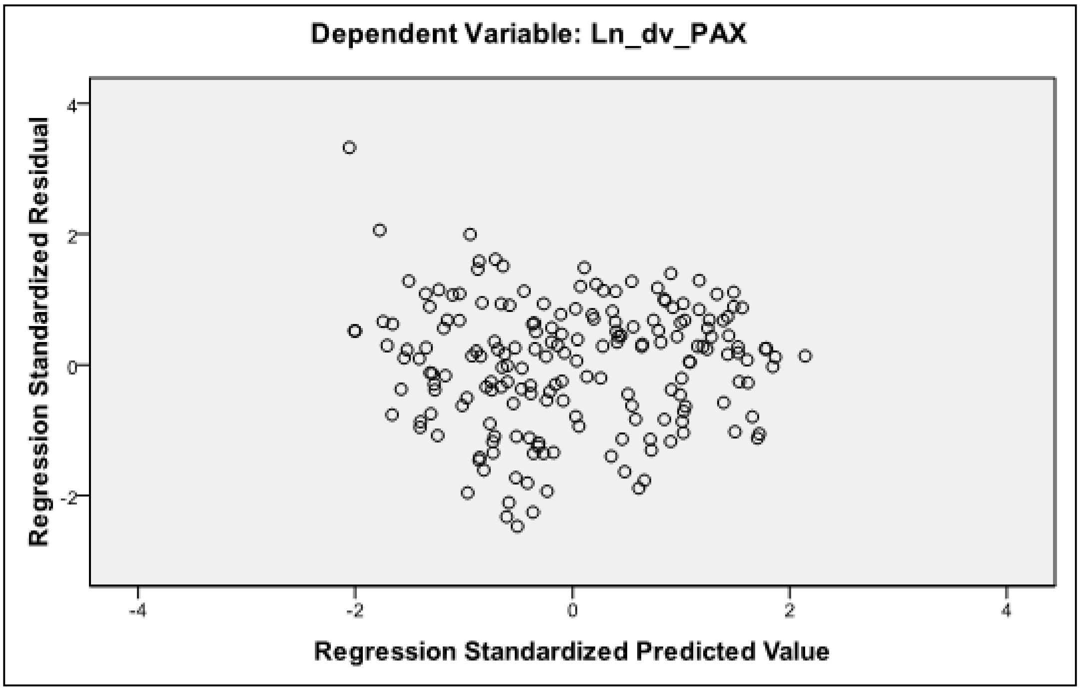

Fig.5.7 Scatter plot of Predicted vs. Residuals of Final Regression Model

Standardization term in figures refers to a statistical measurement that shows a data points' distance to population mean in standard deviations.

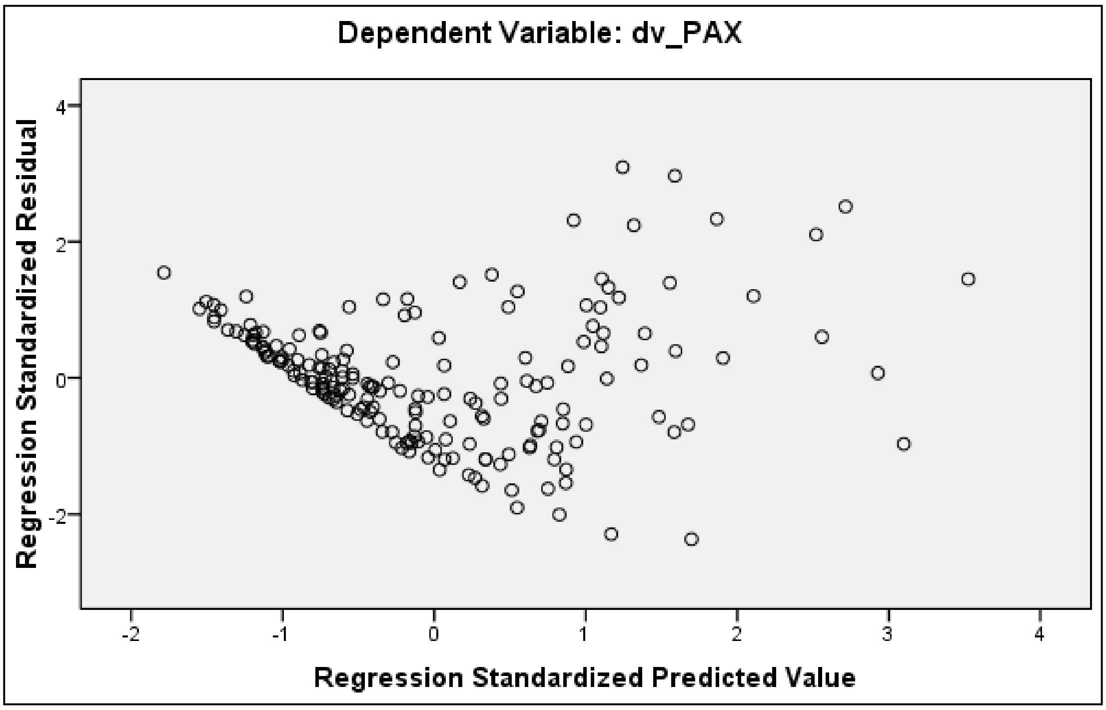

Fig.5.8 Scatter plot of Predicted vs. Residuals of a Regression Model with Untransformed Data

5.3.2.4 Tests and Validity of the Final Regression Model:

Statistical tests specific to regression analysis are investigated below. More general statistical tests will be carried out in further sections.

F-Value:

F-value was discussed in Chapter 3.1 in detail. In final regression model its value was 25.190 (from Table 5.16). This value alone does not indicate whether success or failure of a model, but it will be helpful for comparison purposes. Smaller F-value suggests that predicted values are closer to original sample set. F values of the regression model and the neural model will be compared in further sections of this chapter.

Overall Significance (P Value):

Statistical significance of independent variables was checked one by one in Section 5.3.2.1. P value suggests to significance of the overall model and its value is 0.00 for the final model (Table 5.15), which is a desired value. The smaller α (or p) gets, the model gets more significant.

R-Square:

R-square is a value which represents wellness of fit of a line. It was studied in detail in Chapter 3.1. It gets maximum value of 1 for perfect fit line and 0 for minimum fit. In this case it has a value of 0.715 which represents 71.5% fit. This number can be considered as a satisfactory level since the data is volatile, heteroscedastic and represents a real-life problem and not a laboratory study.

5.3.2.5 Results of the Regression Model:

Passenger demand estimations of the Zafer_2 and Zafer_3 airport scenarios and Or-Gi airport for years 2020 and 2009 according to final regression model (Eqn.5.3) are given in Table 5.17. Estimations of remaining airports can be found in Appendix P.

Table 5.17 Predicted passenger numbers for 2009 and 2020 by using Regression Model

Airport	Estimation of Passengers for 2009	Estimation of Passengers for 2020
Zafer_2 Airport	142,332	230,567
Zafer_3 Airport	186,073	306,274
Or-Gi Airport	371,232	987,971

According the final regression model, most significant variables are given in Table 5.18 from most significant to least.

Table 5.18 List of Independent Variables by Their Significance According to Regression Analysis

<table>
<tr><td>1</td><td>Geographic Regions</td><td rowspan="3">Very High Significance</td></tr>
<tr><td>2</td><td>Socioeconomic Regions & GDPPC</td></tr>
<tr><td>3</td><td>Population</td></tr>
<tr><td>4</td><td>Bed Capacity</td><td rowspan="3">Moderately Significant</td></tr>
<tr><td>5</td><td>Number of Export Companies</td></tr>
<tr><td>6</td><td>Gravity Coefficient</td></tr>
<tr><td>7</td><td>Export Amount</td><td rowspan="5">Insignificant</td></tr>
<tr><td>8</td><td>Airliner Profit</td></tr>
<tr><td>9</td><td>Highway vs. Air Travel</td></tr>
<tr><td>10</td><td>Aviation Taxes</td></tr>
<tr><td>11</td><td>Urban Population</td></tr>
</table>

As it was mentioned in Chapter 3.1, multi-linear regression assumes strong linear relationship between dependent and independent variables. Statistical significance tests for the linear-regression models are based on this linearity concept as well. Since the data is not *fully* linear, statistical significance test results are debatable but they provide an idea of the reasons behind passenger demand.

5.4 Applying Neural Network Analysis:

5.4.1 Data selection:

Even though neural networks are more tolerant to missing data, outliers and heteroscedasticity, it is better to eliminate those conditions in order to get better results. The outliers and inconsistent data were removed in data selection section in earlier parts of this chapter. Final data which was presented in Appendix N was also used in neural analysis. No data transformation is necessary since neural networks do not require.

5.4.2 Neural Architecture Selection:

Each forecasting data is unique and it should be treated according to its own properties and needs. There is no neural architecture or structure that gives best solutions to all problems, so a neural model should be specifically created and further modified by forecaster for the specific problems. During the analysis with neural networks, it is observed that there are no 100% correct methods or parameters for obtaining the best result. Because of this uncertainty, an intensive trial-error study was needed. During this trial-error study phase, more than 200 trials were carried out and a suitable neural architecture was formed. The success of the trial models were measured by error tests given in Chapter 3.3. The best neural architecture for used data is studied below:

Number of Hidden Layers:

Best number of hidden layers in a neural model has no exact solution yet but some opinions and rule of thumb rules exist. Sontag (1992) suggests in MLP's with step activation functions; there is need of two hidden layers for full generality. In most of the forecasting studies in the literature, one hidden layer is used. In order to keep the model simpler and be parallel with the literature, one hidden layer is used.

Number of Hidden Nodes:

There are many opinions about best number of hidden nodes. Lippmann (1987), Hecht-Nielsen (1990), Zhang, Pauwo and Hu (1998) suggested that 2n+1 is the best number of hidden nodes in multi-layer perceptron models whereas n is the number of input nodes. Similarly Wong (1991) suggested 2n and Kang (1991) offered n/2 hidden nodes. Bailey

(1990) gives 0.75n is the best solution whereas Kasstra (1996) and Boyd (1996) gives 1.5n to 3n as the best interval. In this model, it is decided to use software default; because during initial trials it is observed that the number of hidden nodes selected by software was better than randomly selected ones. Most successful hidden nodes were greater than 4n.

Activation Function:

Sigmoid function is a widely known activation function and in this neural model this function will be used for both activation and output functions. Step activation functions are not suitable for this study (we are not looking for a yes no answer), and hyperbolic functions can generate negative values which would be illogical. Because of these reasons, it is concluded that sigmoid activation function may be the most suitable activation function for the real-life problems.

Training Methods:

In neural network section, training methods were introduced; which were batch and online methods. In batch method, all neurons were taken in to memory and analyzed; whereas online method works neuron by neuron basis which makes it more suitable for bigger datasets. In this study, there were only 189 observations and during initial trials it was observed that batch method gives better results so it was decided to use batch method instead of online.

A Proposal for Training Neurons with Semi-Guidance:

It was mentioned before in Chapter 3.2 that best training method for this study would be back-propagated supervised learning method. Two methods for minimizing errors were introduced namely: scaled conjugate and conjugate gradient methods. During the trial studies, it was observed that two methods released quite similar results yet the performance of scaled conjugate method was slightly better. Because of this performance, in this study it was decided to use scaled conjugate method.

During training of neurons, almost all of the neural network software packages divide data into three sections; which are training data, testing data and holdout data. During training of neurons, training data is used as model for training neurons and holdout data is kept out of process in order to give an objective idea of success of the model. The percentages of these dividends are subjective to nature of the source data. I.e. some forecasters may allocate 90% of their data for training purposes and some datasets may be too small for that kind of percentage.

During training in this study, inconsistencies were observed with the predicted data. When the percent of the training data increased relative to the testing data, this inconsistency was eliminated. The random selection of testing and training observations is thought to be the reason behind this inconsistency. For example by chance, software could choose only eastern cities for training purposes and train the neural network accordingly. In order to prevent this situation, a feature of the software was used which enables forecaster to pick training and testing observations one-by-one basis. As training of the neurons minimizes errors, selection of observations is an important decision for neural architecture. During selection, following assumptions were made:

- Each category should have at least one testing observation
- Each city should have at least one testing observation
- Selection of testing neurons should be random but parallel with the given assumptions

Expectedly, statistical errors were minimized by this guided training. 27 observations were chosen for testing purposes and 162 observations were allocated for training.

5.4.3 Results of the Neural Model:

During initial trials, a neural network with properties given in this section was formed and performances of the models were measured with tests like ME, MAE and MAPE which were introduced in Chapter 3.3. During out of more than 200 trials, one neural model generated lowest error values and it is given in Table 5.19:

Table 5.19 Error Test Results of the Selected Neural Model

	Selected Neural Model
MAPE	61.11
MSE	3.27E+09
ME	8108
Maximum Residual Of Over Forecasting	326,698
Maximum Residual Of Lower Forecasting	-155,448
F-Test	14.55

As it was stated earlier, the smaller values are more desirable in these tests. Detail properties of the selected neural model are presented below:

Table 5.20 shows number of cases. Excluded six variables refer to six planned airports Zafer_2, Zafer_3 and Or-Gi for years 2009 and 2020.

Table 5.20 Summary Case Processing Properties for the Neural Model

Case Processing Summary

		N	Percent
Sample	Training	162	85.7%
	Testing	27	14.3%
Valid		189	100.0%
Excluded		6	
Total		195	

Table 5.21 shows summary of the model. Sum of squares error is the error of the output layer in sigmoid transformed values. For the stopping rule 1 consecutive step(s) with no decrease in error option is used.

Table 5.21 Model Summary for the Neural Model

Model Summary

Training	Sum of Squares Error	.170
	Relative Error	.048
	Stopping Rule Used	1 consecutive step(s) with no decrease in error
	Training Time	0:00:00.197
Testing	Sum of Squares Error	.108
	Relative Error	.099

Table 5.22 shows the software output of the summary neural structure. In the table, *factors* refer to categorization variables and *covariates* refer to numerical input data for the model.

As it was stated earlier 1 hidden layer is generated with 5 hidden units. Activation function is sigmoid and one dependent variable is defined, which is number of passengers.

Table 5.22 Network information of the Neural Model

Network Information

Input Layer	Factors	1	b7_Aviation_Tax
		2	Socioeconomic Categories
		3	b12_Geographic_Categories
	Covariates	1	b1_Population
		2	b2_Urban_Population
		3	b3_GDPPC
		4	b5_Airliner_Profit
		5	b6_Highway_vs_Air
		6	b8_Export
		7	b9_Export_Companies
		8	b10_Bed_Capacity
		9	b4_Gravity_Coef
		Number of Units	25
		Rescaling Method for Covariates	Standardized
Hidden Layer(s)		Number of Hidden Layers	1
		Number of Units in Hidden Layer 1	5
		Activation Function	Sigmoid
Output Layer	Dependent Variables	1	dv_PAX
	Number of Units		1
	Rescaling Method for Scale Dependents		Normalized
	Activation Function		Sigmoid
	Error Function		Sum of Squares

Table 5.23 shows synaptic weights of the model. Those weights have no meaning for the model or help any interpretation but can be used for make predictions for different conditions (i.e. different planned airports or different time intervals).

Table 5.23 Synaptic Weights of the Neural Model

Parameter Estimates

Predictor		Predicted					
		Hidden Layer 1					Output Layer
		H(1:1)	H(1:2)	H(1:3)	H(1:4)	H(1:5)	dv_PAX
Input Layer	(Bias)	-.390	-.203	-.253	.027	1.274	
	[Socioeconomic_Categories=AT]	-.397	.542	-.319	.098	.622	
	[Socioeconomic_Categories=RA1]	.837	.002	.046	.833	.771	
	[Socioeconomic_Categories=RA2]	.027	-.434	.452	.523	.083	
	[Socioeconomic_Categories=RA3]	.102	.401	-.616	-.888	-.267	
	[b12_Geographic_Categories=AG]	.031	-.643	-.276	.731	.177	
	[b12_Geographic_Categories=CA]	-.942	-.174	-.818	-.207	-.086	
	[b12_Geographic_Categories=CEA]	-1.246	.355	-.700	.036	.119	
	[b12_Geographic_Categories=EBS]	-.808	1.191	-.766	-1.609	-.240	
	[b12_Geographic_Categories=EM]	.327	-.744	.104	-.052	-.129	
	[b12_Geographic_Categories=ME]	1.577	-.603	1.727	1.542	.998	
	[b12_Geographic_Categories=NEA]	.843	.130	-.067	-.623	-.441	
	[b12_Geographic_Categories=SEA]	1.117	.566	.932	.407	.077	
	[b12_Geographic_Categories=WBS]	-1.073	.803	-1.549	-.357	-.342	
	[b12_Geographic_Categories=WM]	-.017	-.835	.390	-.100	.626	
	[b7_Aviation_Tax=0]	-.379	.321	.289	-.128	.737	
	[b7_Aviation_Tax=1]	-.020	-.542	.291	.383	1.277	
	b1_Population	.561	1.378	.587	-1.500	.519	
	b2_Urban_Population	.008	1.500	-.524	-1.220	-.136	
	b3_GDPP	-1.786	-.660	-.334	.721	-.996	
	b4_Gravity_Coef	-.707	-.234	1.071	.414	.652	
	b5_Airliner_Profit	.007	.467	.107	.078	-.787	
	b6_Land_vs_Air	-1.805	-1.259	-1.732	.764	-1.446	
	b8_Export	.819	.931	-.824	-.218	.387	
	b9_Export_Companies	.362	.550	-.200	.034	.474	
	b10_Bed_Capacity	-.835	.236	-.190	-.706	-.370	

Table 5.23 Continued

Hidden Layer 1	(Bias)						.494
	H(1:1)						-2.536
	H(1:2)						2.994
	H(1:3)						-2.334
	H(1:4)						-2.281
	H(1:5)						-1.829

Fig. 5.9 shows distribution of residuals against predicted values. From the figure, it can be seen that, residuals increase as the number of passengers increase. Reason behind this increase in residuals may be described with the number of the observations. Number of observations with crowded airports is less than the number of observations with smaller airports. Because of use of more data, it can be said that neurons were trained better with the behaviour with smaller airports and they predicted the demand accordingly. Fig. 5.10 displays the synaptic connections of the neural model. Darker lines represent the synaptic weights greater than zero and the lighter lines represent the negative weights. The thicknesses of the lines are depending on the weights.

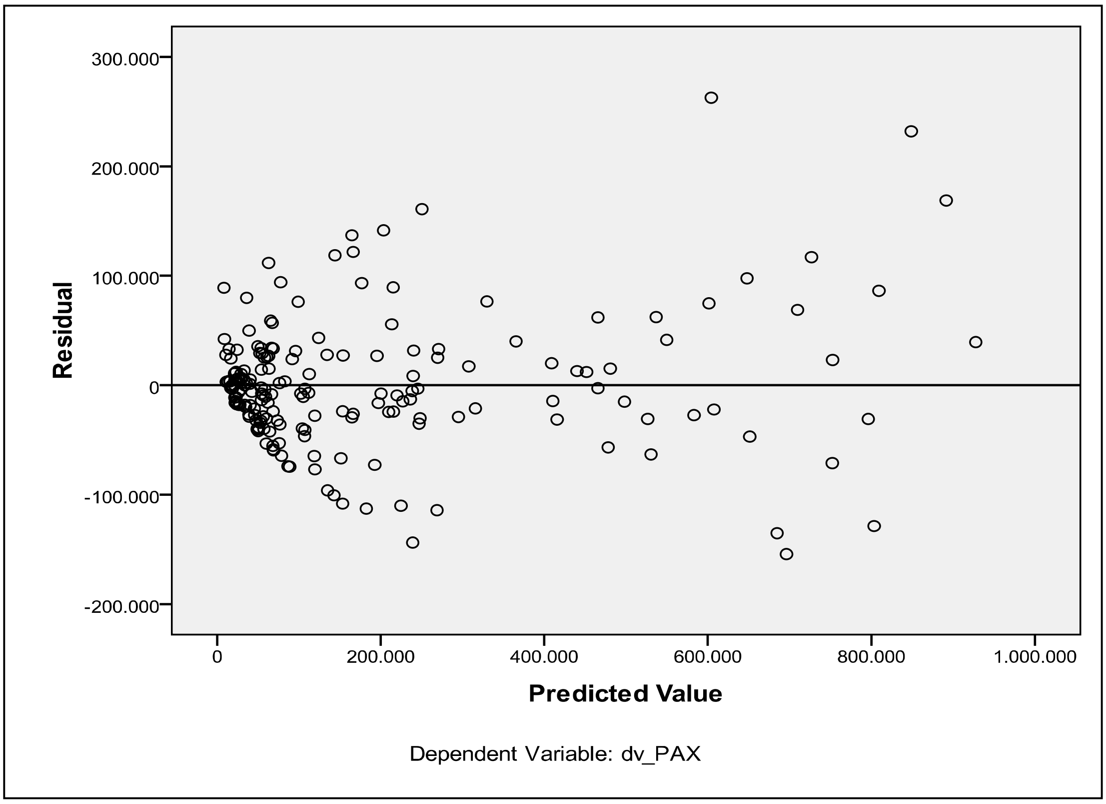

Fig.5.9 Scatter plot of Residuals vs. Predicted Values

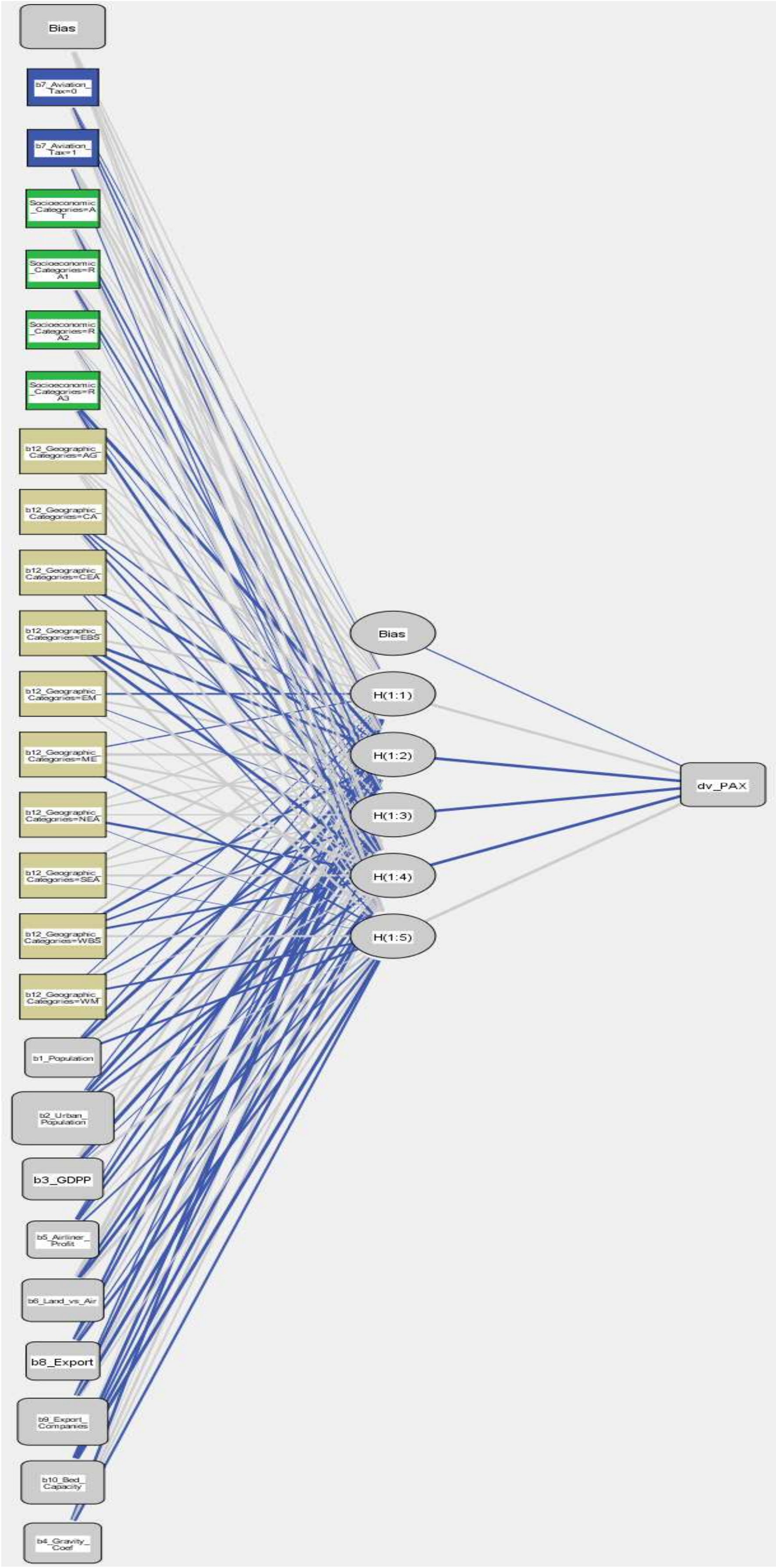

Fig.5.10 Synaptic Connections of the Neural Model

Table 5.24 shows the predicted passenger numbers for years 2009 and 2020. Appendix P shows neural predictions of all airports.

Table 5.24 Passenger Number Prediction for 2020 by Neural Networks

	Predictions for year 2009 With Neural Model	Predictions for year 2020 With Neural Model
Or-Gi Airport	598,986	934,781
Zafer_2 Airport	172,532	217,387
Zafer_3 Airport	200,768	322,167

SPSS software also does a sensitivity analysis for the significance of the parameters in the model. These parameters are shown in Fig.5.11. The significance of the inputs differs from the ones in regression analysis. In almost all trials it was seen that urban population was the most important value for the neural model. Export companies variable was very insignificant whereas export values were moderately significant. Aviation taxes variable was observed as irrelevant to number of the passengers. Airliner profit had very less impact for neural model either. Comparison of importance of variables will be studied in detail in succeeding section.

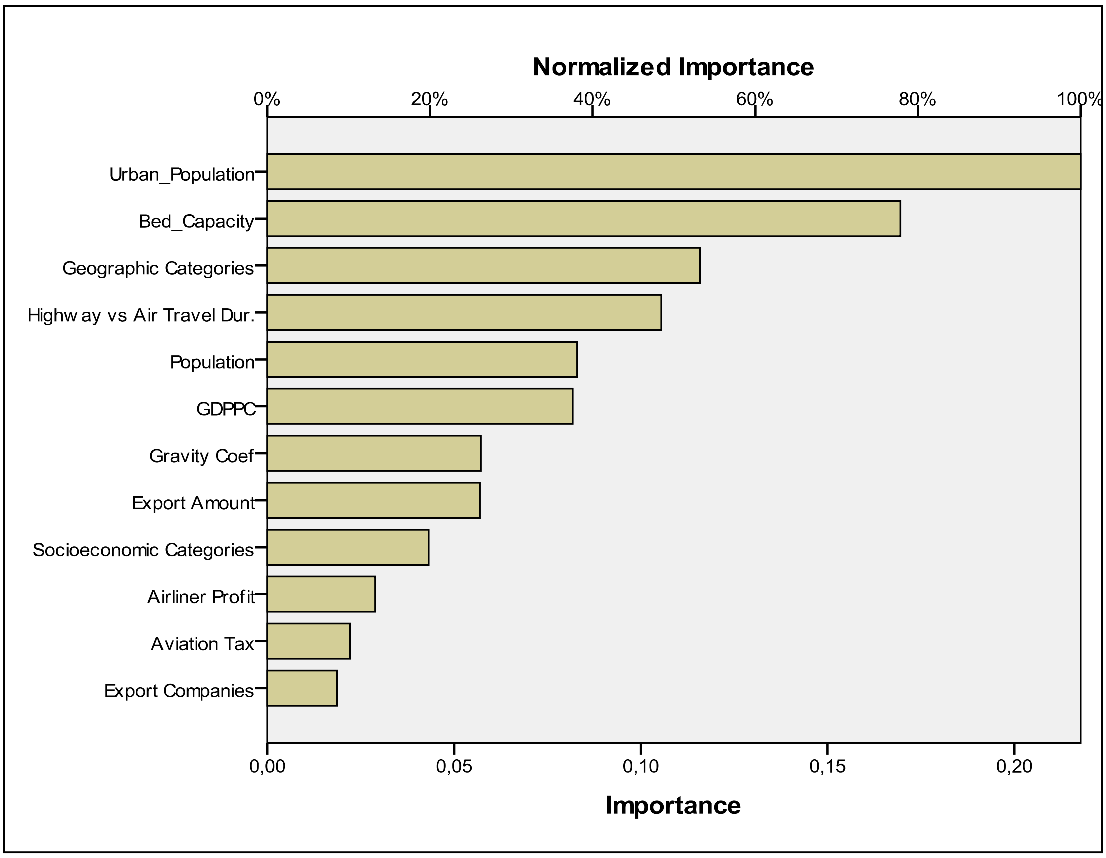

Fig. 5.11 Importance Analysis of Variables in Neural Model

5.5 Comparing Neural and Regression Models:

Estimations of passenger demand of 2009 and 2020 of planned airports are given in Table 5.25 for regression and Neural Models. It can be seen that both models produced similar results although they are based on different mathematical approaches. Close numbers strengthens the validity of the both models.

Table 5.25 Passenger Number Prediction for 2009 and 2020 by Neural and Regression Models

	2009 Predictions		2020 Predictions	
Airport Case	Passenger Number Prediction for 2009 with Regression Model	Passenger Number Prediction for 2009 with Neural Model	Passenger Number Prediction for 2020 with Regression Model	Passenger Number Prediction for 2020 with Neural Model
Or-Gi Airport	371,232	598,986	987,971	934,781
Zafer_2 Airport	142,332	172,532	230,567	217,387
Zafer_3 Airport	186,073	200,768	306,274	322,167

Error values of the two models are listed in Table 5.26. It is observed that neural model have lower error values which is expected because neural model is able to reflect both linear and non-linear relations between dependent and independent variables.

Fig. 5.12 and Fig.5.13 depict actual versus predicted values of regression and neural models. The inclined line in the figures represents y=x equation, which refers to best prediction performance. It can be seen from Fig.5.13 that in neural model, predicted values are closer to inclined line which means it showed a better prediction performance. The number of actual passengers with regression and neural predictions can be found in Appendix P. Predicted numbers refer to x axis values of Fig. 5.12 and 5.13.

After evaluating error values and figures 5.12 & 5.13, it can be concluded that neural model performed better than regression model for this study. But this may not be the case in all forecast studies. As it was mentioned before, correct forecasting method depends on nature of the problem, size of dataset and properties of the observations.

Table 5.26 Comparison of Statistical Test Results between Neural and Regression Models

	Neural Model	Regression Model
MAPE	61.11	67.89
MSE	3.27E+09	1.78E+10
ME	8108	33991
Maximum Residual Of Over Forecasting	326,698	605,571
Minimum Residual Of Lower Forecasting	-155,448	-338,240
F-Test	14.55	25.19

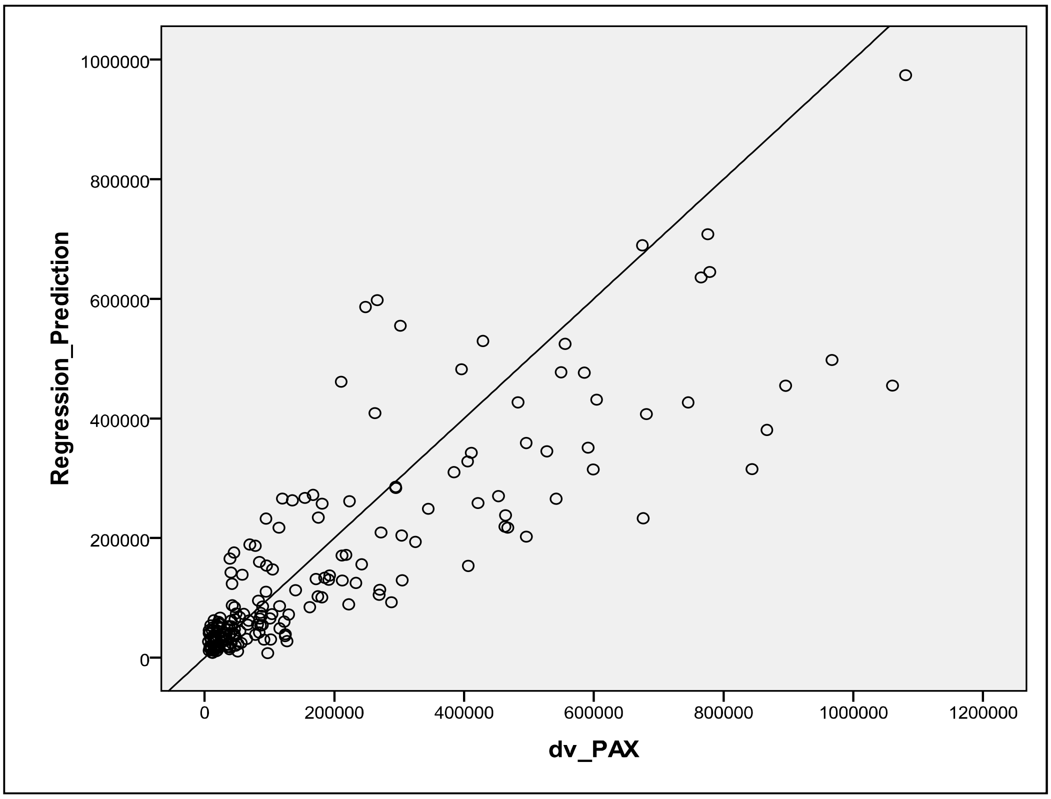

Fig.5.12 Scatter Plot of Actual Passenger Numbers and Predictions for 2020 by Regression Model

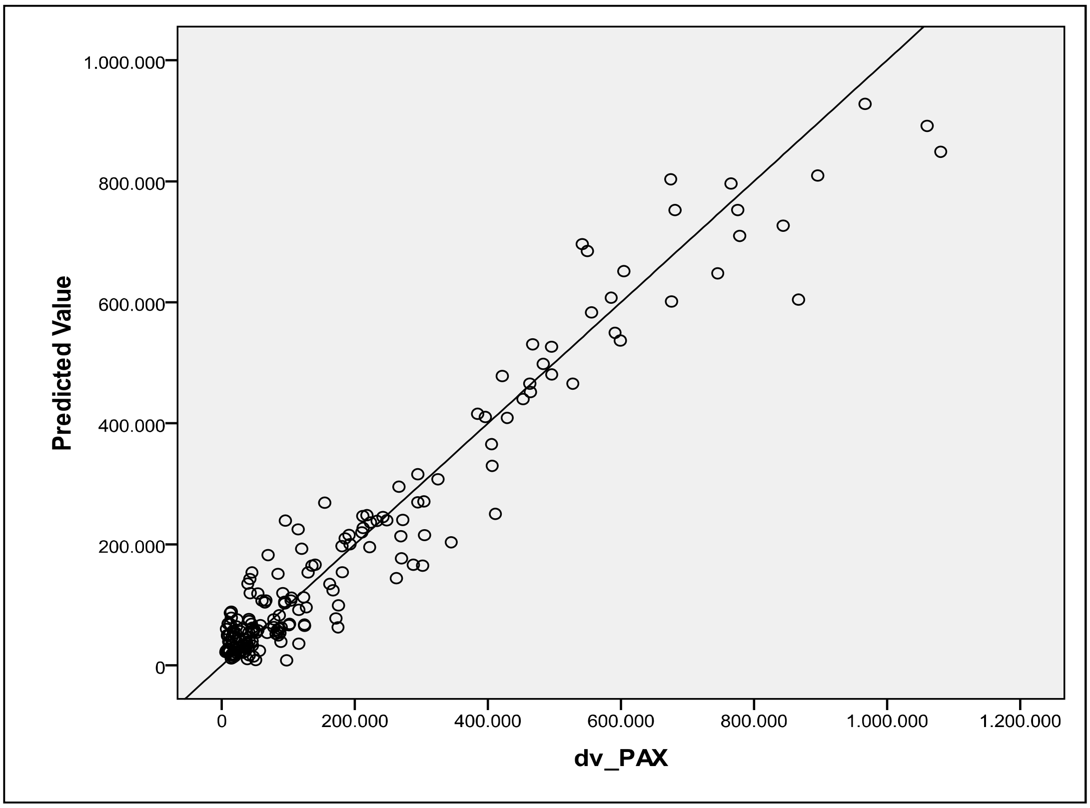

Fig.5.13 Scatter Plot of Actual Passenger Numbers and Predictions for 2020 by Neural Model

<u>5.6 Results of the Analysis:</u>

The comparisons of the significance of the variables are given in Table 5.27. Variables are listed from most significant to least. In regression analysis, variables which are impacted by change in R^2 value (Table 5.13) more than 10% were considered as highly significant variables, which effect from 10% to 3% were considered as moderately significant and the remaining were considered as insignificant. Similarly in neural sensitivity analysis (Fig.5.11) ; items which were effecting analysis more than 50% were considered as highly significant, between 50% and 35% were considered as moderately significant and the remaining were considered as insignificant. Those boundary values were selected since most of the variables were grouped between mentioned intervals. Percentages are different between neural and regression models because they use different methods for determining statistical significance.

In Table 5.27, it is observed that some variables are significant in both models and some variables are not. Sensitivity analysis of the neural model is a better analysis than regression model for this study because it can reflect non-linear relations. The details of the variables are studied below:

Geographic Regions: This variable is highly significant in both neural and regression model. This situation was expected.

Population and Urban Population: In regression model, population is one of the most significant variables and urban population is one of the least. During elimination of the independent variables in regression analysis, both urban population and population showed insignificance yet after removing urban population, population variable gained significance (Table 5.8). This situation may happen because of collinearity and it may not be a sign of statistical insignificance. It is interesting that both models have one population variable in highly significant variable list. It can be concluded that population is one of the key factors behind demand of air transportation.

Socioeconomic Regions: This variable is highly significant for regression analysis and shows no significance in neural model. The distribution of the regions in the data was not homogeneous and this may be the reason behind this different result. After evaluating these results, it is concluded that there is no strong evidence whether socioeconomic region is a factor behind passenger demand or not.

Table 5.27 Significance of the Independent Variables

Regression Model		Neural Model
Geographic Regions	Very High Significance	Urban Population
Socioeconomic Regions		Bed Capacity
GDPPC		Geographic Regions
Population		
Bed Capacity	Moderately Significant	Highway vs. Air Travel
Number of Export Companies		Population
Gravity Coefficient		GDPPC
Export Amount		
Airliner Profit	Insignificant	Gravity Coefficient
Highway vs. Air Travel		Export Amount
Aviation Taxes		Socioeconomic Regions
Urban Population		Airliner Profit
		Aviation Taxes
		Number of Export Companies

GDPPC: GDPPC is highly significant in regression analysis and moderately significant in neural model. It can be concluded that GDPPC is an effecting factor behind passenger demand.

Number of Export Companies: Number of export companies is an insignificant variable in neural model and moderately significant in regression analysis. It can be concluded that number of export companies in a city/region effect passenger demand.

Export Amount: Export amount is insignificant in neural analysis and moderately significant in regression analysis. It is decided that export amount is a factor behind travel demand. Its low significance is possibly due to collinearity with number of export companies. (Table 5.14).

Bed Capacity: Bed capacity is a moderately important variable in regression and highly important variable in neural model. It can be concluded that touristic infrastructure of a city has impact on air travel demand.

Highway vs. Air Travel and Gravity Coefficient: Highway vs. air travel duration is moderately significant in neural analysis and insignificant in regression analysis. But this situation is vice versa in gravity coefficient. So there are two variables in moderately significant variable list which refer to distance. So it can be said that distance from attraction centers is an effecting factor on air travel demand.

Airliner Profit: This variable is a minor effecting variable in regression model and insignificant in neural model. It can be argued that airliner profit has negligible effect on passenger demand.

In regression analysis section of this chapter, airliner profit variable was not removed from analysis even though it impacted R^2 value for only 0.08%. Although impact of this variable in overall model is negligible, it may be important for a single medium-small size airport. It can be argued that if government supports airliners in predetermined airports (i.e. case study airports of this thesis), the number of passengers may increase dramatically.

Airliner Taxes: Both neural and regression model show that this variable is insignificant for air travel demand. It can be said that, lifted taxes in 2003 can be restored without negative effect on air travel.

As a result, it can be concluded that geographic location of a city, its' distance to attraction centers and its population have most significant effect on air travel demand. Wealth of a city (GDPPC), tourism infrastructure and international trade have moderate effect. Airliner profit and lifted taxes have no effect on passenger numbers. Effect of socioeconomic regions in Turkey could not be determined and requires further study.

CHAPTER 6

CONCLUSION

Air transportation systems and airports having increasing impacts on our social and economic lives should be so planned and designed that they would operate efficiently. Economic analysis is the main process needed for reaching a decision during the planning stage for an airport investment. Future air passenger demand is one of the basic inputs required to carry out economic analysis & design of airports and should be estimated by some means.

This thesis was directed towards to develop a methodology to predict the future passenger demand for planned airports in Turkey. During the initiation of the study there were two planned airports, namely Zafer Airport and Or-Gi Airport, under consideration and they were selected as case studies. Zafer Airport originally was planned to serve the cities of Kütahya and Afyon provided that the existing airport in the neighbor city of Uşak continues to operate in future. This situation is named as Zafer_2 Airport. Another scenario is the condition that the operation of Uşak Airport would stop and Zafer Airport would serve all three neighbor cities. This case is named as Zafer_3 Airport. On the other hand, Or-Gi Airport is planned and expected to serve only Ordu and Giresun.

For the purpose of establishing models for future air passenger demand forecasting, it is necessary to collect and make use of the past data for the factors thought to be effective on air passenger demand generation. It is well known that numerous socioeconomic factors may be considered as effective. In literature these factors widely and commonly called as indicators. In general the data for those indicators are available on nation or city wise basis. GDPPC, population, urban population etc. can be given as examples to such indicators. Also categorical indicators, such as geographical location, socioeconomic classification, periods for different aviation tax policies, were thought to be effective indicators and taken into consideration in this study. These indicators were used in the form of categorical dummy variable.

For a reliable forecasting study, the data should cover a considerably long period of time in the past. During data collection, many difficulties were faced with in obtaining past records for some of the indicators. Because of various reasons, there were missing records for a couple of indicators for some years in early 2000's. Linear approximation methods were applied to complete the records in order to use the data set for the considered year as a complete observation.

Some indicators, though considered, were not used in modeling since it was not possible to obtain the past records for them. For example during initial stages of the study it was assumed that there is a link between communities' need of communication and need of transportation. It was also thought that a community with high use of internet and mobile phones may tend to travel more. After negotiations with Turkish Telekom representatives, it was learned that the records are available only for the last couple of years and they are not open to public. Similarly ticket prices of airliner companies were not available and instead airliner profitability is considered as an alternative indicator.

Even the records were available, some socioeconomic parameters, like car ownership, birth rate and number of students, which were considered at the beginning of the study, later on disregarded since some research results indicate that these parameters are not significant for air passenger demand.

For the available data, suitable forecasting methods should be selected in order to establish reliable models. There are many forecasting methods in the literature and each of them is unique and has its own strengths and weaknesses.

Use of regression analysis is very common in almost all scientific disciplines and it provides useful tools for forecasters. Regression methods assume existence of strong linear or non-linear cause-effect relationship between indicators. Such strong relationships can not be mentioned for the data collected herein. During initial investigation of the data it is observed that linear regression analysis resulted inconsistent predictions, like negative number of passengers, high statistical errors, etc. Data transformation methods were applied in order to prevent these inconsistencies. Natural logarithmic transformation is found to be the best transformation method and the application of this method eliminated such illogical predictions. Unlike regression model, the best neural model performance was achieved with untransformed data. In order to reduce statistical errors, outliers in the dataset were removed and only the existing airports similar to the case study airports were kept.

The regression analysis and accompanying statistical tests showed that the indicators could be ranked according to their impacts on air passenger demand from highest to lowest as follows:

- Geographic regions
- Socioeconomic regions
- GDPPC
- Population
- Touristic bed capacity
- Gravity coefficient
- Number of export companies
- Export amount
- Airliner profit
- Highway versus air travel duration
- Aviation tax policies
- Urban population

It is concluded that urban population and aviation taxes are statistically insignificant and they are not used in regression models. It is also observed that there exist multi-collinearities between gravity coefficient, export amount and number of export companies. These indicators were also removed as well.

The final regression model has R^2 value of 71.5%. This coefficient is evaluated as satisfactory since a real-life situation with highly volatile and heteroscedastic data is used. The model released the following predicted values of air passenger demands for the case study airports for years 2009 and 2020.

Air Passenger Demand Prediction by Using Regression Analysis

	For 2009	For 2020
Zafer_2	142,332	230,567
Zafer_3	186,073	306,274
Or-Gi	371,232	987,971

Similarly neural networks are widely used in forecasting studies in recent years and it can reflect both linear and non-linear relationships between dependent and independent variables. It is understood that in order to obtain satisfactory results from a neural model, a good neural architecture must be formed. There are various different neural architecture forms available but unfortunately there is no exact method for selecting most suitable form. Instead only some suggested rule of thumb methods exist. By using those methods and after many trials, best neural model was formed with a single hidden layer, 5 hidden nodes, sigmoid activation and output function and batch training method with scaled conjugate error minimizing.

During training of the neurons, it was observed that in some cases neural model generated random predictions. The reason behind random predictions was investigated and it is concluded that during training, neural model incidentally picked most of the training observations from specific categories (i.e. picked only eastern Anatolian cities passenger data for training). In order to solve this problem it is necessary to establish more homogeneous training dataset, and this is achieved by applying a semi-guided training method. 27 observations were chosen for testing purposes and 162 observations were allocated for training. Using semi-guided neuron training reduced statistical errors and neural model generated more consistent predictions. Importance of the indicators from highest to lowest according to neural model can be listed as follows:

- Urban Population
- Bed Capacity
- Geographic Categories
- Highway vs. Air Transportation Duration
- Population
- GDPPC
- Gravity Coefficient
- Export Amount
- Socioeconomic Categories
- Airliner Profit
- Aviation Taxes
- Number of Export Companies

The neural model released the following predicted values of air passenger demands for the case study airports for years 2009 and 2020.

Air Passenger Demand Prediction by Using Neural Analysis

	For 2009	For 2020
Zafer_2	172,532	217,387
Zafer_3	200,768	322,167
Or-Gi	598,986	934,781

Comparison of the results of neural and regression analysis showed that both models generated similar results. After evaluating statistical tests and prediction charts, it is concluded that neural network model performed better than the regression model. The reason behind this superior performance is thought to be the ability of neural network models to reflect both linear and non-linear relationships between variables.

After comparing significance of the variables from both models, it is concluded that geographic location of a city, its distance to attraction centers and its population have most significant effect on air travel demand. Wealth of a city (GDPPC), tourism infrastructure and international trade have moderate effects. Airliner profit and lifted taxes have no effect on passenger demand.

Although established models generated consistent results, they have some weak points. For example in order to predict future passenger numbers, socioeconomic indicators of the future conditions should be predicted. During last ten years, demographic indicators had a steady trend in Turkey and it was easy to obtain demographic information for the future. But economic and social indicators changed rapidly. It is very difficult to predict future conditions of such dynamic variables. Because of these difficulties, it is best to use similar models established in this study for medium range forecasts (i.e. 5 to 10 years) and use different models for more than 10 years of forecast ranges. Neural models work with trial & error methods and it is very difficult to understand how the predictions are formed. For example there is no detailed information about neural weights and sensitivity analysis carried out in Chapter 5. Neural network software found those values with unknown (black- box) measures. These properties of neural networks may be pointed as weaknesses in itself.

On the other hand, there are many strong sides of the models used in this study. For example the data used in this thesis is based on quantitative records and 189 actual observations during last ten years. Although the data is highly volatile, it is objective and certain. Using models based on such objective data increased validity of the research. Another important point to be mentioned is that although two different methods used in this study inherit different mathematical approaches, they produced similar predictions; which may be considered as the indication of success of both models.

Some additional approaches can be practiced in future studies. For instance, in this study, a quantitative output (passenger demand), independent parameters and quantitative methods were used. In literature, it is observed that there are many widely used qualitative classification methods. In future studies, airports can be categorized into different scales with respect to their size or passenger numbers and a categorical study can be carried out by using such methods.

During categorization of the indicators, the independent variables were used city vise manner and inter-city relations were neglected. For example, in real life Trabzon Airport serves neighboring cities but that effect is neglected because it is very difficult to measure such interactions. A survey study can be carried out for determining such intercity relations. Luckily, almost all airports in this study are medium-small size airports and they serve the cities that they were built in. Because of these reasons, it is thought that the effect of intercity relations have negligible impact on the models. However, if a similar study focusing on larger airports would be carried, than such relations should be taken into consideration.

In further studies, investigating different forecasting methods may be considered. For example judicial methods can be used and combined with neural models. Delphi method may be considered in judicial approaches. Also dynamic systems and chaos theory branch of applied mathematics may provide forecasters with very useful methods. The author thinks combining a survey study with similar forecasts like this work would strengthen the model significantly.

Results of this study are giving an idea of future passenger demand of Zafer and Or-Gi airports. Also the importance of some socioeconomic indicators effective on passenger demand generation was evaluated. In addition to that, this study demonstrates that even with heteroscedastic and volatile data, consistent results can be obtained by using correct forecasting models and handling data correctly. Methods used in this study may give an idea to technocrats, forecasters and decision makers about possible use of modern forecasting techniques before making large investments.

REFERENCES

Abbas, K.A. (2006). "Conceptual and Regression Models for Passenger Demand Prediction: A case study of Cairo Airport and Egyptair", Aerlines Magazine [sic].

Abed, S.Y., Bafail, A.O. and Jasimuddin S. M. (2001). "An Econometric Analysis of International Air Travel Demand in Saudi Arabia", Journal of Air Transport Management.

Alekseev, K.P.G. and Seixas, J.M. (2009). "A Multivariate Neural Forecasting Modeking for Air Transport – Preprocessed by Decomposition: A Brazilian Application", Journal of Air Transport Management.

Bafail, A. O. (2000). "Appliyng Data Mining Techniques to Forecast Number of Airline Passengers in Saudi Arabia", Conference on Artificial Intelligence in Science and Technology (AISAT'2000), Australia.

Blinova, T.O. (2007). "Analysis of Possibility of Using Neural Network to Forecast Passenger Traffic Flows in Russia", International Journal of Aviation.

Chatterjee, S. (2006). "Regression Analysis by Example", Wiley-Interscience, Hoboken.

DeCoster,J. (2006). "Applied Linear Regression Notes Set 1", Lecture Notes, Department of Psychology, University of Alabama, Alabama.

Deutsche Bank.(2006). "Global growth centres 2020: Goals", (http://www.dbresearch.com/PROD/DBR_ INTERNET_EN-PROD/PROD0000000000188752.pdf , page last visited 01 November 2010)

DHMI.(2009). "Statistics Yearbook", Devlet Hava Meydanları. İşletmesi Genel Müdürlüğü Yayını, Ankara.

Doğan, V. (2006). "Forecasting Stock Market Return Using Artificial Neural Networks", Msc. Thesis, Boğaziçi University, Istanbul.

Douglas, M. C. and Runger, G. C. (2002). "Applied Statistics and Probability for Engineers, (3rd Edition)", John Wiley & Sons, Ltd., New York.

Duin, R.P.W. (2000). "Learned from Neural Networks", Theme Presentations, Proc. ASCI 2000, 6th Annual Conf. of the Advanced School for Computing and Imaging, Lommel, Belgium.

Ellsworth, S.R. (2000). "Estimating Air Passenger Travel in the Atlantic Region", Msc. Thesis, Canadian University of New Brunswick, New Brunswick.

Gentry, T. W., Wiliamowski, B. M. and Weatherford L. R. (1995). "A Comparison of Traditional Forecasting Techniques and Neural Networks", Intelligent Engineering Systems Through Artificial Neural Networks vol 5.

Goldman Sachs (2007). "BRICS and Beyond", (http://www2.goldmansachs.com/ideas/brics/book/BRIC-Full.pdf, page last visited 01 November 2010).

Hamzaçebi, C. (2008). "Improving Artificial Neural Networks' Performance in Seasonal Time Series Forecasting", Journal of Information Sciences.

Haykin, S. (2005). "Comprehensive Foundation of Neural Networks", Prentice Hall Publishing Company, New Jersey.

Jayawardena, A. W., Fernando, A.K. and Zhou, M.C. (1996). "Comparison of Multilayer Perceptron and Radial Basis Function Networks as Tools for Flood Forecasting", Conference on Water-Caused Natural Disasters, their Abatement and Control, Anaheim, California.

Karlaftis, M.G. (2008). "Demand Forecasting in Regional Airports: Dynamic TOBIT Models with GARCH Errors", Symposium of Air Transport, Rio de Janeiro, Brasil.

Karlaftis, M.G., Zografos, K.G., Papastavrou, J.D. and Charnes, J.M. (1996). "Methodological Framework for Air-Travel Demand Forecasting", Journal of Transportation Engineering.

Kızılarslan, R. (2008). "Forecasting of Short Term and Mid Term Istanbul Natural Gas Consumption Values by Neural Network Algorithms", Msc. Thesis, Fatih University, Istanbul.

Kröse, B. and Smagt, P. (1996). "An Introduction the Neural Networks", Lecture Notes, Dutch University of Amsterdam, Amsterdam.

Law, R. and Au, N. (1999). “A Neural Network Model to Forecast Japanese Demand for Travel to Hong Kong”, Journal of Tourism Management.

Levenbach, H. and Cleary, J.P. (2006). “Forecasting: Practice and Process for Demand Management”, Thomson, Brooks and Cole Publishing, Belmont.

Mendenhall, W. and Sincich, T. (1992). “Statistics for Engineering and the Sciences, (3rd Edition)”, Macmillan Publishing Company, New York.

Meng, J. and Yang, Z. (2006). “Civil Aviation Passenger Traffic Volume Forecasting Based on Fuzzy Diagonal Regression Neural Networks”, IMACS Multiconference on Computational Engineering in Systems Applications, Beijing, China.

Meza, J.C. (2010). “Steepest Descent”, Wiley Interdisciplinary Reviews: Computational Statistics.

Naudé, W.A and Saayman, A. (2004). “The Determinants of Touristic Arrivals in Africa: A Panel Data Regression Analysis”, International Conference, Centre for the Study of African Economies, University of Oxford, Oxford.

Neufville, R. and Odoni, A.R. (2003).“Airport systems: Planning, design and management”, McGraw-Hill Publishing Company, New York.

OECD. (2010). “Glossary of Statistics”, (http://stats.oecd.org/glossary/detail.asp?ID=2708, page last visited 26 October 2010).

Princeton University Library Data and Statistics Services. (2007). “Regression Analysis”, (http://dss.princeton.edu/online_help/analysis/analysis.htm , page last visited 29 September 2010).

Profillidis, A.V. and Botzoris, G.N. (2006). “Econometric Models for the Forecast of Passenger Demand in Greece”, Journal of Statistics & Management Systems.

Profillidis,V.A. (2000). “Econometric and Fuzzy Models for the Forecast of Demand in the Airport of Rhodes”, Journal of Air Transport Management.

Profillidis,V.A. and Botzoris,G. (2005). “A Comparative Analysis of the Forecasting Ability of Classic Econometric and Fuzzy Models”, Fuzzy Economic Review.

Rengaraju, V.R., and Arasan, V.T. (1992). “Modeling for Air Travel Demand”, Journal of Transportation Engineering.

Reyna, O.T., (2006). “Getting Started in Fixed/Random Effect Models Using R”, (http://dss.princeton.edu/training/Panel101R.pdf, page last visited 01 November 2010)

Shewchuk, J.R. (1994). “An Introduction to the Conjugate Gradient Method , Edition 1¼”, School of Computer Science, Carnegie Mellon University, Pittsburgh.

Smyth, G.K. (2002). “Encyclopedia of Environmetrics. Volume III”, John Wiley & Sons Ltd., New York.

Sözgen, B. (2009). “Neural Network and Regression Models to Decide Whether or Not to Bid for a Tender in Offshore Petroleum Platform Fabrication Industry”, Msc. Thesis, Middle East Technical University, Ankara.

SPSS Inc., (2007). “SPSS 17.0 Neural Networks User Guide”, Chicago.

Sven, F. C. (2005). “Forecasting with Artificial Neural Networks”, Tutorial, Department of Management Science, Lancaster University, Lancaster.

Tabachnick, B. G. & Fidell, L.S. (1989). “Using Multivariate Statistics, (2nd. Edition)”, Harper Collins, New York.

Taneja, N.K. (1975). “Statistical Evaulation of Econometric Air Travel Demand Models”, Journal of Aircraft.

Viglioni, G.M.C. (2007). “Methodology for Railway Demand Forecasting Using Data Mining”, SAS Global Forum, Rio de Janeiro, Brasil.

World Bank. (2010). “Gross Domestic Product 2009”, (http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP.pdf , page last visited 01 November 2010).

Zhang, G.P. (2004). “Neural Networks in Business Forecasting”, IRM Press, Hershey.

APPENDIX A

LIST OF TURKISH AIRPORTS BY PASSENGER NUMBERS

Table A.1 List of Turkish Airports By Passenger Numbers

AIRPORT	2001	2002	2003	2004
Adana	757,140	685,836	786,855	1,147,483
Adıyaman	242			
Ağrı	8,538	9,312	8,307	9,576
Amasya-Merzifon				
Ankara-Esenboğa	3,159,315	2,836,628	2,783,927	3,275,725
Antalya	9,170,469	10,334,951	10,371,600	13,656,053
Balıkesir	519			
Balıkesir-Körfez	2,848	3,063	3,567	1,649
Bursa-Yenişehir		169	2,807	14,112
Çanakkale		222		319
Denizli-Çardak	35,397	34,600	37,741	46,119
Diyarbakır	222,221	185,262	211,750	495,942
Elazığ	56,593	46,238	40,709	39,007
Erzincan	12,023	6,712	8,377	10,253
Erzurum	103,917	94,610	104,821	217,984
Eskişehir				
GaziAntep	212,273	271,975	223,303	411,213
Isparta-S.Demirel	5,922	2,871	2,883	3,861
İstanbul-Atatürk	12,601,431	11,357,691	12,104,342	15,600,601
İzmir-A. Menderes	2,464,278	2,489,392	2,337,749	2,942,281
K.Maraş	3,458	239		
Kars	51,743	46,941	54,312	86,281
Kayseri	180,802	242,134	324,959	467,326
Konya	82,991	58,112	78,162	94,678
Malatya	84,193	87,512	89,545	140,230
Mardin	31,895	25,930	19,538	22,060
Muğla-Bodrum	1,286,303	1,619,513	1,599,568	2,036,624
Muğla-Dalaman	2,147,221	2,374,301	2,255,074	2,747,454
Muş	16,834	17,300	18,142	34,227
Nevşehir	19,430	16,703	15,781	9,932
Samsun-Çarşamba	174,638	171,648	175,300	294,710
Siirt	9,613			
Sinop				
Sivas	4,318		3,082	7,804
Şanlıurfa-Gap				
Tekirdağ-Çorlu	97,253	51,010	14,291	9,964
Tokat				
Trabzon	405,509	396,028	429,047	775,699
Uşak				
Van-Ferit Melen				

Table A.1 Continued

AIRPORT	2005	2006	2007	2008	2009
Adana	1,708,952	2,216,747	2,302,535	2,290,427	2,482,402
Adıyaman	6,864	37,669	48,621	86,280	85,112
Ağrı	12,736	22,884	42,621	60,360	14,169
Amasya-Merzifon				13,888	39,577
Ankara-Esenboğa	3,829,854	4,547,578	4,958,128	5,692,133	6,084,404
Antalya	15,864,863	14,642,043	17,710,385	18,789,257	18,345,693
Balıkesir			1,313		256
Balıkesir-Körfez		10,727	21,806	17,399	
Bursa-Yenişehir	18,394	24,893	51,724	75,462	73,496
Çanakkale	150	3,700	41,079	21,259	19,207
Denizli-Çardak	66,276	129,694	151,212	157,361	150,780
Diyarbakır	676,098	843,852	895,625	967,088	1,060,381
Elazığ	45,303	69,578	119,877	135,293	344,844
Erzincan	21,097	41,326	64,681	91,540	127,030
Erzurum	303,751	453,013	591,105	527,598	599,017
Eskişehir			15,504	45,477	78,323
GaziAntep	210,539	466,584	734,427	754,968	833,002
Hatay			2,965	162,128	325,307
Isparta-S.Demirel	4,048	38,258	47,564	15,053	16,461
İstanbul-Atatürk	19,293,769	21,265,974	23,196,229	28,553,132	29,812,888
İzmir-A. Menderes	3,660,586	4,411,034	5,236,304	5,455,298	6,201,794
K.Maraş	6,005	33,787	46,861	68,167	81,420
Kars	162,158	270,052	95,421	269,095	288,008
Kayseri	541,956	681,107	765,306	674,833	778,639
Konya	167,252	262,561	248,070	266,143	301,724
Malatya	304,565	406,425	421,444	463,817	462,884
Mardin	41,256	115,626	191,383	192,764	233,288
Muğla-Bodrum	2,494,328	2,375,478	2,578,100	2,749,788	2,780,944
Muğla-Dalaman	3,171,228	2,707,982	2,895,967	3,208,668	3,347,996
Muş	28,362	35,984	23,905	88,875	115,795
Nevşehir	17,126	27,832	54,054	100,762	122,753
Samsun-Çarşamba	384,434	483,089	555,796	604,387	866,862
Siirt	11,994	18,097	14,278	12,581	
Sinop				14,464	47,147
Sivas	39,413	18,716	101,959	124,357	124,137
Şanlıurfa-Gap	42,281	84,542	114,681	154,657	181,155
Tekirdağ-Çorlu	14,853	36,477	29,768	6,882	40,778
Tokat		11,958	44,483	21,828	
Trabzon	1,080,689	1,472,957	1,482,760	1,469,713	1,596,905
Uşak		14,158	31,328	25,305	10,327
Van-Ferit Melen	294,547	495,749	549,521	585,319	745,493

APPENDIX B

DETAILS OF MULTI-LINEAR REGRESSION ANALYSIS

B.1 Formulation and Details of Significance and Validity for Regression Models:

As it was discussed in Chapter 3, various test's and control methods are widely used for checking significance and validity of multi-linear regression models. Before giving details of these methods, some coefficients are defined below:

"k" : this value stands for degree of freedom. As previously discussed in this chapter, a standard regression equation can be displayed as $y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon$ and "k" value in this equation represents degrees of freedom of the regression model, which may be defined as "*number of known parameters -1*".

"n" : this value stands for number of observations in a dataset.

"p" : this value stands for number of parameters in regression equation.

"s" : s value refers to variance of the samples. $s_p^2 = \frac{\sum(x_p - \bar{x}_p)}{n_p}$.

"x" : independent variable(s) are shown this way.

"y" : dependent variable.

"i" *subscript*: "i" subscript refers to i.th values of any variable in a dataset.

"p" *subscript*: "p" subscript refers to any predicted variable.

"t" *subscript*: "t" subscript refers to any target variable. Target means actual values of an observation.

"α" : This coefficient refers to a specific level of confidence level. I.e. when there is 95% confidence level is mentioned, α value refers to 0.05.

" ¯ ": bar sign stands for arithmetic mean. For example, $\bar{y}$ stands for arithmetic mean of all dependent variables in a data set.

" ^ ": hat sign refers to specific predicted observation i.e. $\hat{y}_i$ refers to prediction of the i.th dependent variable.

B.1.1 F-Test:

SS_E , also known as Error sum of squares, can be represented as $SS_E = \sum_{t=1}^{n}(y_t - \hat{y}_i)^2$. Similarly $SS_R = \sum_{t=1}^{n}(\hat{y}_i - \bar{y})^2$ is known as regression sum of squares. So according to Eqn. B.1, total corrected sum of squares, can be shown as $SS_T = \sum_{t=1}^{n}(y_i - \bar{y})^2$.

$$SS_T = SS_R + SS_E \qquad \text{Eqn. B.1}$$

Under these assumptions & data following equation can be written as

$$F = \frac{SS_R/k}{SS_E/(n-p)} = \frac{MS_R}{MS_E} \qquad \text{Eqn. B.2}$$

Where MS_R stands for the mean square from regression and likewise MS_E refers to mean square of errors (or residuals).

B.1.2 Student's t-test, p-value and Significance:

Although there are various applications and formulas of t-statistic, a generalized formula is given below:

$$t = \frac{\bar{x}-\bar{y}}{\sqrt{\frac{s_t^2}{n_1}+\frac{s_p^2}{n_2}}} \qquad \text{Eqn. B.3}$$

In least square method, t values are computed as regression coefficient divided by respective standard errors. After obtaining "t" values, with using student distribution charts, p-values are obtained. Most of the statistic software compares the t statistic on the regression variables with values in the Student's t distribution to determine p-value (Princeton University, Data and Statistical Services, 2007).

B.1.3 R-square, Wellness of Fit :

R^2 can be determined by dividing total corrected sum of squares to regression sum of squares. It can be formulated as follows:

$$R^2 = \frac{SS_R}{SS_T} = 1 - \frac{SS_E}{SS_T} \qquad \text{Eqn. B.4}$$

R square adjusted (R^2_{adj}) is a similar term as R^2 can be defined by Eqn.3.5.

$$R^2_{adj} = 1 - \frac{SS_e/(n-p)}{SS_T/(n-1)} \qquad \text{Eqn. B.5}$$

B.2 Use of Dummy Variables:

As it was mentioned in chapter 3, general form of multi- linear regression is $y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon$. If it is decided to add a dummy variable D, which is 1 for existence and 0 for lack of a qualitative indicator (i.e. existence of aviation taxes) the equation will take the following form in Eqn.B.6:

$$y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon + \gamma D \qquad \text{Eqn. B.6}$$

From Eqn.B.6, if existence of the indicator is substituted in the equation with its value (1 is assumed for existence), Eqn.B.7 is obtained:

$$y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon + \gamma \qquad \text{Eqn. B.7}$$

More than one category can be modelled in regression equations. For example 4 categories, namely north, south, east and west; are required to be included in a regression equation. Coefficients of N, S, E and W are assumed to refer to respective directions. If “n” refers to number of categorization indicators, then “n-1” numbers of coefficients should be included in regression equation. If all “n” numbers of the categorical items were included in the equation, than the case of perfect multicollinearity (singularity) would arise. The omitted coefficient does not change the result of the regression equation thus any of them can be removed. If W indicator assumed as removed, regression equation would form Eqn.B.8 which is derived from Eqn.B.7.

$$y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon + \gamma_1 N + \gamma_2 S + \gamma_3 E \qquad \text{Eqn. B.8}$$

In order to reflect effects of the assumed categories in regression equation, required values are listed in Table B.1.

Table B.1 Dummy γ Coefficients for Eqn.B.8

	Value of N	Value of S	Value of E
Case N	1	0	0
Case S	0	1	0
Case E	0	0	1
Case W	0	0	0

As it can be seen from the Table B.1., there is no need for assigning any value for modeling omitted W case. Regression equation for Case N would yield to Eqn.3.9.

$$y = \beta_0 + \beta_1 x1 + \beta_2 x2 + \cdots + \beta_k xk + \varepsilon + \gamma_1 \qquad \text{Eqn. B.9}$$

APPENDIX C

DETAILS OF NEURAL NETWORKS

C.1 Artificial Neuron:

Artificial neuron is an information transferring and processing unit like biological neuron. It is similar to but simpler than a biological neuron. Artificial neurons are consists of three basic elements. First one is synapses, which has its own weight. Second is an adder or summing junction (this part is also known as propagation function). In this part, all signals from synapses come together and summed. Third part is the activation function. This function limits the value of output to boundary of +1 and -1. An artificial neuron is presented in Fig. C.1.

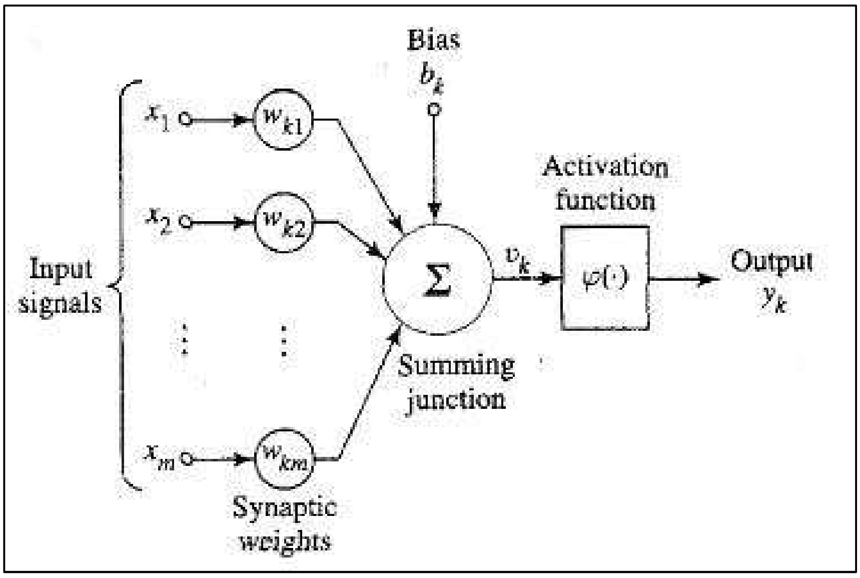

Fig. C.1 Sample Model of an Artificial Neuron
(source: Neural Networks, a Comprehensive Foundation by Simon Haykin, 1999)

In mathematical sense, neuron can be described by following set of equations:

$$u_k = \sum_{j=1}^{m} w_{kj} . x_j \qquad \text{Eqn.C.1}$$

$$y_k = \varphi(u_k + b_k) \qquad \text{Eqn.C.2}$$

$$v_k = u_k + b_k \qquad \text{Eqn.C.3}$$

$$v_k = \sum_{j=1}^{m} w_{kj} . x_j \qquad \text{Eqn.C.4}$$

Where $x_1, x_2, \dots, x_m$ are input signals and $w_{k1,} w_{k2}, \dots, w_{km}$ are synaptic weights of neuron k; u_k is linear combined output due to input signals, b_k is bias; $\varphi(.)$ is activation function; and y_k is output signal of the neuron. Bias is an external indicator and can be both positive and negative. It might not exist in every neural model but usually exists. It can be considered as synonymous to regression constant of regression models. Eqn.C.4 is combination of Eqn.C.2 and Eqn.C.3.

C.2 Functions:

Functions were discussed briefly in Chapter 3. Graphical representation of these functions can be seen in Fig C.2 and details about the functions are given as below:

Linear Function:

Input and output values are linearly proportional to each other in a linear sense. Mathematical representation can be given as:

$$\varphi(v) = \begin{cases} 1, & v \geq +\frac{1}{2} \\ v, & \frac{1}{2} > v > -\frac{1}{2} \\ 0, & v \leq -\frac{1}{2} \end{cases} \qquad \text{Eqn.C.5}$$

The linear function and linear set of equations may raise the question whether traditional linear regression models and the neural networks are the same. The traditional regression model can acquire knowledge through the least-squares method and store that knowledge in regression coefficients. In this sense, it is a neural network. In fact, one can argue that linear regression is a special case of certain neural networks. However, linear regression has a rigid model structure and set of assumptions that are imposed before learning from the data. (SPSS Neural Networks Handbook, 2007)

Threshold Function (Binary Function):

Threshold Function (Binary Function): This function generates output of binary data which is 0-1 or positive-negative result. This function is also known as Heaviside function. Mathematical representation is given below:

$$\varphi(v) = \begin{cases} 1, & if\ v \geq 0 \\ 0, & if\ v < 0 \end{cases} \qquad \text{Eqn.C.6}$$

Whereas the output can be written as:

$$y_k = \begin{cases} 1, & if\ v_k \geq 0 \\ 0, & if\ v_k < 0 \end{cases} \qquad \text{Eqn.C.7}$$

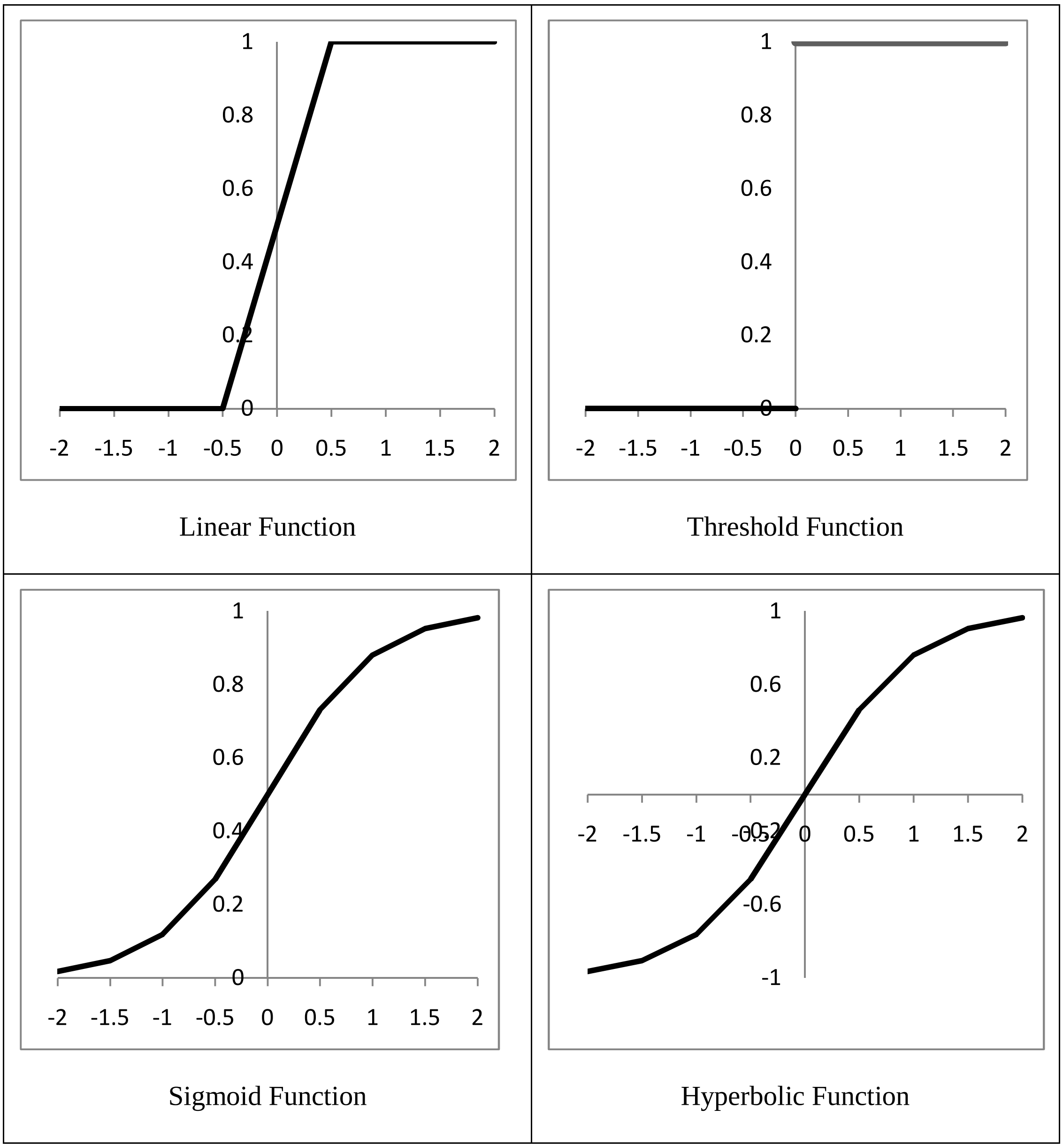

Fig.C.2 Widely Used Functions in Neural Networks

<u>Sigmoid Function:</u>

Sigmoid Function is a widely used s-shaped function and it displays part linear and part non-linear behavior. It is also known as logistic function. Formulation of the function is given in Eqn.C.8.

$$\varphi(v) = \frac{1}{1+\exp(-av)} \qquad \text{Eqn.C.8}$$

In the formulation "a" stands for a varying parameter which creates sigmoid function with different slopes. A sigmoid function with a=2 value is displayed in Fig.C.2

Hyperbolic Function:

Some neural networks use hyperbolic tangent function. This function is known with producing negative values as well as positive values. Function can be described as:

$$\varphi(v) = tanh\,(v) \qquad \text{Eqn.C.9}$$

C.3 Scaled Conjugate Gradient Method:

Although neural network software make use of complex eigenvector matrices for solving scaled conjugate gradient approximations, the solution can be demonstrated simply by using linear algebra. The sample proof is given by Shewchuk (1994).

The large systems of linear equations can be solved in matrix form of equations; a form like this can be identified as:

$$Ax = b \qquad \text{Eqn.C.10}$$

Where x is the vector of unknowns, b is the vector of known values and A is a positive-definite matrix. Eqn. C.10 can be written as:

$$\begin{bmatrix} A_{11} & A_{12} & \cdots & A_{1n} \\ A_{21} & A_{22} & & A_{2n} \\ \vdots & & \ddots & \vdots \\ A_{n1} & A_{n2} & \cdots & A_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix} \qquad \text{Eqn.C.11}$$

The inner product of two vectors is written like $x^T y$, and represents the scalar sum $\sum_{i=1}^{n} x_i y_i$. It should be noted that *f(x)* is minimized by the solution b .

$$f(x) = \frac{1}{2}x^T Ax - b^T x + c \qquad \text{Eqn.C.12}$$

Residual $r_{(i)}$ would be $r_{(i)} = b - Ax_{(i)}$ since minimized *f(x)* equals to b . In this method, an iteration places to search for the minima. An equation for the search is described as:

$$x_{(1)} = x_{(0)} + \alpha r_{(0)} \qquad \text{Eqn.C.13}$$

Where x values refer to iterations and α is value for minimizing f along a line. After noting $r_{(i)} = b - Ax_{(i)}$ and $f'\left(x_{(1)}\right) = -r_{(1)}$, following equations can be written:

$$r_{(1)}^T r_{(0)} = 0$$

$$(b - Ax_{(1)})^T r_{(0)} = 0$$

$$(b - A(x_{(0)} + \alpha r_{(0)}))^T r_{(0)} = 0$$

$$(b - Ax_{(0)})^T r_{(0)} - \alpha(Ar_{(0)})^T r_0 = 0$$

$$(b - Ax_{(0)})^T r_{(0)} = \alpha(Ar_{(0)})^T r_{(0)}$$

$$r_{(0)}^T r_{(0)} = \alpha r_{(0)}^T (Ar_{(0)})$$

$$\alpha = \frac{r_{(0)}^T r(0)}{r_{(0)}^T A r_{(0)}}$$

Eqn.C.14

After that, if all equations combined the following equations can be summoned:

$$r_{(i)} = b - Ax_{(i)}$$

$$\alpha_i = \frac{r_{(i)}^T r(i)}{r_{(i)}^T A r_{(i)}}$$

$$x_{(i+1)} = x_{(i)} + \alpha_i r_i$$ Eqn.C.15

<u>C.4 Gradient Descent Method:</u>

Gradient descent method, also known as steepest descent method, is one of the earliest minimization routines. It was first mentioned by Cauchy in 1847. This is a similar iterative method like scaled conjugate gradient method.

For finding the minimum of a function $f(x), x \in \mathbb{R}^n$, and $f: \mathbb{R}^n \rightarrow \mathbb{R}$,

$$x_{k+1} = x_k + \alpha_k d_k = 0,1, \ldots,$$ Eqn. C.16

Where α_k is the step length which can be shown as:

$$\alpha_k = arg_\alpha \min f\ (x_k + \alpha d_k)$$ Eqn. C.17

In Eqn.C.17, argmin refers to the argument of the minimum for the given function and search direction d_k is described as: $d_k = -\nabla f(x_k)$.

APPENDIX D

POPULATION OF TURKISH CITIES

Table D.1 Population of Turkish Cities

	2000	*2001*	*2002*	*2003*	*2004*	*2005*
Turkey	67,803,927	*68,201,403*	*68,598,879*	*68,996,355*	*69,393,831*	*69,791,307*
Adana	1,849,478	*1,871,932*	*1,894,386*	*1,916,840*	*1,939,294*	*1,961,748*
Adıyaman	623,811	*617,947*	*612,083*	*606,219*	*600,355*	*594,491*
Ağrı	528,744	*529,049*	*529,354*	*529,659*	*529,964*	*530,269*
Amasya	365,231	*360,009*	*354,787*	*349,565*	*344,343*	*339,121*
Ankara	4,007,860	*4,073,417*	*4,138,974*	*4,204,531*	*4,270,088*	*4,335,645*
Antalya	1,719,751	*1,729,686*	*1,739,621*	*1,749,556*	*1,759,491*	*1,769,426*
Balıkesir	1,076,347	*1,082,343*	*1,088,339*	*1,094,335*	*1,100,331*	*1,106,327*
Bursa	2,125,140	*2,170,103*	*2,215,066*	*2,260,029*	*2,304,992*	*2,349,955*
Çanakkale	464,975	*466,569*	*468,163*	*469,757*	*471,351*	*472,945*
Denizli	850,029	*858,215*	*866,401*	*874,587*	*882,773*	*890,959*
Diyarbakır	1,362,708	*1,376,709*	*1,390,710*	*1,404,711*	*1,418,712*	*1,432,713*
Elazığ	569,616	*565,565*	*561,514*	*557,463*	*553,412*	*549,361*
Erzincan	316,841	*302,084*	*287,327*	*272,570*	*257,813*	*243,056*
Erzurum	937,389	*915,611*	*893,833*	*872,055*	*850,277*	*828,499*
Eskişehir	557,028	*535,250*	*513,472*	*491,694*	*469,916*	*448,138*
GaziAntep	1,285,249	*1,324,503*	*1,363,757*	*1,403,011*	*1,442,265*	*1,481,519*
Hatay	1,253,726	*1,272,655*	*1,291,584*	*1,310,513*	*1,329,442*	*1,348,371*
Isparta	513,681	*500,276*	*486,871*	*473,466*	*460,061*	*446,656*
İstanbul	10,018,735	*10,383,750*	*10,748,765*	*11,113,780*	*11,478,795*	*11,843,810*
İzmir	3,370,866	*3,423,507*	*3,476,148*	*3,528,789*	*3,581,430*	*3,634,071*
K.Maraş	1,002,384	*1,002,674*	*1,002,964*	*1,003,254*	*1,003,544*	*1,003,834*
Kars	325,016	*323,186*	*321,356*	*319,526*	*317,696*	*315,866*
Kayseri	1,060,432	*1,075,383*	*1,090,334*	*1,105,285*	*1,120,236*	*1,135,187*
Konya	2,192,166	*2,158,869*	*2,125,572*	*2,092,275*	*2,058,978*	*2,025,681*
Malatya	853,658	*834,859*	*816,060*	*797,261*	*778,462*	*759,663*
Mardin	705,098	*710,910*	*716,722*	*722,534*	*728,346*	*734,158*
Muğla	715,328	*722,590*	*729,852*	*737,114*	*744,376*	*751,638*
Muş	453,654	*446,777*	*439,900*	*433,023*	*426,146*	*419,269*
Nevşehir	309,914	*305,649*	*301,384*	*297,119*	*292,854*	*288,589*
Samsun	1,209,137	*1,211,969*	*1,214,801*	*1,217,633*	*1,220,465*	*1,223,297*
Siirt	263,676	*267,655*	*271,634*	*275,613*	*279,592*	*283,571*
Sinop	225,574	*221,694*	*217,814*	*213,934*	*210,054*	*206,174*
Sivas	755,091	*738,430*	*721,769*	*705,108*	*688,447*	*671,786*
Şanlıurfa	1,443,422	*1,454,805*	*1,466,188*	*1,477,571*	*1,488,954*	*1,500,337*
Tekirdağ	623,591	*638,564*	*653,537*	*668,510*	*683,483*	*698,456*
Tokat	828,027	*798,412*	*768,797*	*739,182*	*709,567*	*679,952*
Trabzon	975,137	*941,628*	*908,119*	*874,610*	*841,101*	*807,592*
Uşak	322,313	*323,999*	*325,685*	*327,371*	*329,057*	*330,743*
Van	877,524	*892,117*	*906,710*	*921,303*	*935,896*	*950,489*
Kutahya	656903	*646476*	*636049*	*625622*	*615195*	*604768*
Afyon	812416	*796582*	*780748*	*764914*	*749080*	*733246*
Uşak	322313	*323999*	*325685*	*327371*	*329057*	*330743*
Ordu	887765	*863143*	*838521*	*813899*	*789277*	*764655*
Giresun	523819	*508632*	*493445*	*478258*	*463071*	*447884*

Table D.1 Continued

	2006	2007	2008	2009
Turkey	*70,188,783*	70,586,256	71,517,100	72,561,312
Adana	*1,984,202*	2,006,650	2,026,319	2,062,226
Adıyaman	*588,627*	582,762	585,067	588,475
Ağrı	*530,574*	530,879	532,180	537,665
Amasya	*333,899*	328,674	323,675	324,268
Ankara	*4,401,202*	4,466,756	4,548,939	4,650,802
Antalya	*1,779,361*	1,789,295	1,859,275	1,919,729
Balıkesir	*1,112,323*	1,118,313	1,130,276	1,140,085
Bursa	*2,394,918*	2,439,876	2,507,963	2,550,645
Çanakkale	*474,539*	476,128	474,791	477,735
Denizli	*899,145*	907,325	917,836	926,362
Diyarbakır	*1,446,714*	1,460,714	1,492,828	1,515,011
Elazığ	*545,310*	541,258	547,562	550,667
Erzincan	*228,299*	213,538	210,645	213,288
Erzurum	*806,721*	784,941	774,967	774,207
Eskişehir	*426,360*	724,849	741,739	755,427
GaziAntep	*1,520,773*	1,560,023	1,612,223	1,653,670
Hatay	*1,367,300*	1,386,224	1,413,287	1,448,418
Isparta	*433,251*	419,845	407,463	420,796
İstanbul	*12,208,825*	12,573,836	12,697,164	12,915,158
İzmir	*3,686,712*	3,739,353	3,795,978	3,868,308
K.Maraş	*1,004,124*	1,004,414	1,029,298	1,037,491
Kars	*314,036*	312,205	312,128	306,536
Kayseri	*1,150,138*	1,165,088	1,184,386	1,205,872
Konya	*1,992,384*	1,959,082	1,969,868	1,992,675
Malatya	*740,864*	722,065	733,789	736,884
Mardin	*739,970*	745,778	750,697	737,852
Muğla	*758,900*	766,156	791,424	802,381
Muş	*412,392*	405,509	404,309	404,484
Nevşehir	*284,324*	280,058	281,699	284,025
Samsun	*1,226,129*	1,228,959	1,233,677	1,250,076
Siirt	*287,550*	291,528	299,819	303,622
Sinop	*202,294*	198,412	200,791	201,134
Sivas	*655,125*	638,464	631,112	633,347
Şanlıurfa	*1,511,720*	1,523,099	1,574,224	1,613,737
Tekirdağ	*713,429*	728,396	770,772	783,310
Tokat	*650,337*	620,722	617,158	624,439
Trabzon	*774,083*	740,569	748,982	765,127
Uşak	*332,429*	334,115	334,111	335,860
Van	*965,082*	979,671	1,004,369	1,022,310
Kutahya	*594341*	583910	565884	571804
Afyon	*717412*	701572	697365	701326
Uşak	*332429*	334115	334111	335860
Ordu	*740033*	715409	719278	723507
Giresun	*432697*	417505	421766	421860

The data shown in italics is approximation. Details can be found in Chapter 4.The information is obtained from Turkish Statistics Institute (http://www.tuik.gov.tr, page last visited 01 November 2010).

APPENDIX E

URBAN POPULATION OF TURKISH CITIES

Table E.1 Urban Population of Turkish Cities

	2000	*2001*	*2002*	*2003*	*2004*	*2005*
Turkey	67,803,927	*68,201,403*	*68,598,879*	*68,996,355*	*69,393,831*	*69,791,307*
Adana	1,849,478	*1,871,932*	*1,894,386*	*1,916,840*	*1,939,294*	*1,961,748*
Adıyaman	623,811	*617,947*	*612,083*	*606,219*	*600,355*	*594,491*
Ağrı	528,744	*529,049*	*529,354*	*529,659*	*529,964*	*530,269*
Amasya	365,231	*360,009*	*354,787*	*349,565*	*344,343*	*339,121*
Ankara	4,007,860	*4,073,417*	*4,138,974*	*4,204,531*	*4,270,088*	*4,335,645*
Antalya	1,719,751	*1,729,686*	*1,739,621*	*1,749,556*	*1,759,491*	*1,769,426*
Balıkesir	1,076,347	*1,082,343*	*1,088,339*	*1,094,335*	*1,100,331*	*1,106,327*
Bursa	2,125,140	*2,170,103*	*2,215,066*	*2,260,029*	*2,304,992*	*2,349,955*
Çanakkale	464,975	*466,569*	*468,163*	*469,757*	*471,351*	*472,945*
Denizli	850,029	*858,215*	*866,401*	*874,587*	*882,773*	*890,959*
Diyarbakır	1,362,708	*1,376,709*	*1,390,710*	*1,404,711*	*1,418,712*	*1,432,713*
Elazığ	569,616	*565,565*	*561,514*	*557,463*	*553,412*	*549,361*
Erzincan	316,841	*302,084*	*287,327*	*272,570*	*257,813*	*243,056*
Erzurum	937,389	*915,611*	*893,833*	*872,055*	*850,277*	*828,499*
Eskişehir	557,028	*535,250*	*513,472*	*491,694*	*469,916*	*448,138*
GaziAntep	1,285,249	*1,324,503*	*1,363,757*	*1,403,011*	*1,442,265*	*1,481,519*
Hatay	1,253,726	*1,272,655*	*1,291,584*	*1,310,513*	*1,329,442*	*1,348,371*
Isparta	513,681	*500,276*	*486,871*	*473,466*	*460,061*	*446,656*
İstanbul	10,018,735	*10,383,750*	*10,748,765*	*11,113,780*	*11,478,795*	*11,843,810*
İzmir	3,370,866	*3,423,507*	*3,476,148*	*3,528,789*	*3,581,430*	*3,634,071*
K.Maraş	1,002,384	*1,002,674*	*1,002,964*	*1,003,254*	*1,003,544*	*1,003,834*
Kars	325,016	*323,186*	*321,356*	*319,526*	*317,696*	*315,866*
Kayseri	1,060,432	*1,075,383*	*1,090,334*	*1,105,285*	*1,120,236*	*1,135,187*
Konya	2,192,166	*2,158,869*	*2,125,572*	*2,092,275*	*2,058,978*	*2,025,681*
Malatya	853,658	*834,859*	*816,060*	*797,261*	*778,462*	*759,663*
Mardin	705,098	*710,910*	*716,722*	*722,534*	*728,346*	*734,158*
Muğla	715,328	*722,590*	*729,852*	*737,114*	*744,376*	*751,638*
Muş	453,654	*446,777*	*439,900*	*433,023*	*426,146*	*419,269*
Nevşehir	309,914	*305,649*	*301,384*	*297,119*	*292,854*	*288,589*
Samsun	1,209,137	*1,211,969*	*1,214,801*	*1,217,633*	*1,220,465*	*1,223,297*
Siirt	263,676	*267,655*	*271,634*	*275,613*	*279,592*	*283,571*
Sinop	225,574	*221,694*	*217,814*	*213,934*	*210,054*	*206,174*
Sivas	755,091	*738,430*	*721,769*	*705,108*	*688,447*	*671,786*
Şanlıurfa	1,443,422	*1,454,805*	*1,466,188*	*1,477,571*	*1,488,954*	*1,500,337*
Tekirdağ	623,591	*638,564*	*653,537*	*668,510*	*683,483*	*698,456*
Tokat	828,027	*798,412*	*768,797*	*739,182*	*709,567*	*679,952*
Trabzon	975,137	*941,628*	*908,119*	*874,610*	*841,101*	*807,592*
Uşak	322,313	*323,999*	*325,685*	*327,371*	*329,057*	*330,743*
Van	877,524	*892,117*	*906,710*	*921,303*	*935,896*	*950,489*
Kutahya	656903	*646476*	*636049*	*625622*	*615195*	*604768*
Afyon	812416	*796582*	*780748*	*764914*	*749080*	*733246*
Uşak	322313	*323999*	*325685*	*327371*	*329057*	*330743*
Ordu	887765	*863143*	*838521*	*813899*	*789277*	*764655*
Giresun	523819	*508632*	*493445*	*478258*	*463071*	*447884*

Table E.1 Continued

	2005	2006	2007	2008	2009
Turkey	*48,107,409*	*48,927,636*	49,747,859	53,611,723	54,807,219
Adana	*1,550,288*	*1,580,775*	1,611,262	1,763,351	1,805,145
Adıyaman	*331,884*	*330,473*	329,060	329,965	338,617
Ağrı	*273,779*	*278,073*	282,361	265,714	269,147
Amasya	*199,986*	*200,659*	201,331	201,575	205,310
Ankara	*3,969,357*	*4,055,124*	4,140,890	4,395,888	4,513,921
Antalya	*1,072,980*	*1,100,310*	1,127,634	1,273,940	1,331,743
Balıkesir	*628,905*	*639,167*	649,423	662,199	678,732
Bursa	*1,880,270*	*1,930,136*	1,979,999	2,204,874	2,249,974
Çanakkale	*238,341*	*242,895*	247,443	248,008	255,220
Denizli	*447,369*	*454,060*	460,747	620,193	630,997
Diyarbakır	*844,622*	*850,008*	855,389	1,051,511	1,079,160
Elazığ	*382,489*	*386,132*	389,774	384,034	392,722
Erzincan	*130,946*	*122,694*	114,437	113,231	118,695
Erzurum	*506,991*	*496,279*	485,563	485,107	491,038
Eskişehir	*584,693*	*605,073*	625,453	653,663	669,444
GaziAntep	*1,247,266*	*1,294,894*	1,342,518	1,410,286	1,454,097
Hatay	*653,001*	*667,333*	681,665	683,991	715,653
Isparta	*282,021*	*278,113*	274,204	264,855	280,154
İstanbul	*10,577,499*	*10,875,879*	11,174,257	12,569,041	12,782,960
İzmir	*3,048,719*	*3,111,929*	3,175,133	3,450,537	3,525,202
K.Maraş	*570,807*	*577,767*	584,726	598,471	605,531
Kars	*136,850*	*135,791*	134,726	130,625	126,127
Kayseri	*848,714*	*871,986*	895,253	1,001,449	1,027,279
Konya	*1,378,767*	*1,395,557*	1,412,343	1,423,546	1,450,682
Malatya	*473,183*	*467,877*	462,569	492,411	468,310
Mardin	*417,939*	*423,277*	428,611	422,537	422,284
Muğla	*298,476*	*304,503*	310,527	329,126	339,757
Muş	*147,653*	*145,283*	142,913	138,089	139,332
Nevşehir	*142,608*	*143,825*	145,037	146,349	151,689
Samsun	*699,439*	*712,276*	725,111	776,385	802,011
Siirt	*167,987*	*170,880*	173,770	178,960	183,924
Sinop	*100,280*	*100,079*	99,872	101,383	102,678
Sivas	*417,634*	*416,800*	415,961	405,769	417,756
Şanlıurfa	*897,634*	*908,735*	919,832	885,929	899,774
Tekirdağ	*466,067*	*480,205*	494,342	521,554	530,278
Tokat	*365,442*	*358,178*	350,914	346,058	356,246
Trabzon	*420,164*	*408,406*	396,646	390,797	408,103
Uşak	*207,205*	*212,238*	217,267	217,567	221,714
Van	*493,196*	*502,440*	511,678	514,481	527,525
Kutahya	*341,289*	*345,773*	350,255	347,073	358,725
Afyon	*359,873*	*357,474*	355,073	355,753	363,717
Uşak	*207,205*	*212,238*	217,267	217,567	221,714
Ordu	*401,386*	*398,337*	395,283	384,066	399,035
Giresun	*321,354*	*280,861*	240,367	235,647	242,584

The data shown in italics is approximation. Details can be found in Chapter 4.The information is obtained from Turkish Statistics Institute (http://www.tuik.gov.tr, page last visited 01 November 2010).

APPENDIX F

HIGHWAY DISTANCES TO MAJOR CITIES

Table F.1 Highway Distances to Major Cities

	ISTANBUL	ANKARA	IZMIR	Median Dist. To 3-Big
Adana	939	490	900	776
Adıyaman	1,209	756	1,229	1,065
Ağrı	1,405	1,052	1,631	1,363
Amasya	671	335	914	640
Antalya	724	544	446	571
Balıkesir	390	530	173	364
Bursa	243	382	322	316
Çanakkale	320	653	325	433
Denizli	647	477	224	449
Diyarbakır	1,364	911	1,418	1,231
Elazığ	1,211	758	1,287	1,085
Erzincan	1,036	683	1,262	994
Erzurum	1,225	872	1,451	1,183
Eskişehir	330	233	579	381
GaziAntep	1,125	672	1,105	967
Hatay	1,130	681	1,091	967
Isparta	601	421	382	468
K.Maraş	1,045	592	1,081	906
Kars	1,425	1,072	1,651	1,383
Kayseri	772	319	848	646
Konya	668	258	550	492
Malatya	1,113	660	1,198	990
Mardin	1,450	997	1,430	1,292
Muğla	780	622	225	542
Muş	1,417	1,010	1,539	1,322
Nevşehir	729	276	767	591
Samsun	735	416	995	715
Siirt	1,551	1,098	1,601	1,417
Sinop	691	428	1,007	709
Sivas	893	441	1,020	785
Şanlıurfa	1,262	809	1,242	1,104
Tekirdağ	132	585	505	407
Tokat	785	379	958	707
Trabzon	1,068	749	1,328	1,048
Uşak	499	368	211	359
Van	1,637	1,233	1,762	1,544
Kutahya	360	311	334	335
Afyon	460	256	327	348
Uşak	499	368	211	359
Ordu	887	568	1,147	867
Giresun	931	612	1,191	911

The data is obtained from Turkish State Directorate of Highways (http://www.kgm.gov.tr, page last visited 01 November 2010)

APPENDIX G

DISTANCE BETWEEN AIRPORTS AND CITY CENTERS

Table G.1 Distance Between Airports and City Centers

	Distance to City Center (km.)	Step 1 Travel Dur. to Airport (min.) (*)	Step 2 Security Checks & Check-in (min.)	Step 3 Board . to Plane (min.)	Step 4 Dur. of Flight (min.)	Step 5 Land. of the plane, baggage claim (min.)	Step 6 Ride from airport to city (min.)	Total Av. Air Travel Dur. (min.)	Total Highway Travel Duration (min.)	Highway Travel / Air Travel Duration Ratio
Adana	3	4	30	15	55	20	20	146	475	3.25
Adıyaman	13	11	30	15	75	20	20	184	652	3.54
Ağrı	8	10	30	15	96	20	20	199	834	4.20
Amasya	6	7	30	15	45	20	20	143	392	2.73
Ankara	28	24	30	15	36	20	20	173	316	1.82
Antalya	13	11	30	15	40	20	20	149	350	2.34
Balıkesir	5	6	30	15	26	20	20	122	223	1.83
Balıkesir K	5	6	30	15	26	20	20	122	223	1.83
Bursa	56	37	30	15	22	20	20	201	193	0.96
Çanakkale	10	9	30	15	31	20	20	134	265	1.97
Denizli	65	43	30	15	32	20	20	225	275	1.22
Diyarbakır	6	7	30	15	87	20	20	185	754	4.07
Elazığ	12	10	30	15	77	20	20	184	664	3.61
Erzincan	9	11	30	15	70	20	20	175	608	3.48
Erzurum	11	9	30	15	83	20	20	189	724	3.83
Eskişehir	8	10	30	15	27	20	20	129	233	1.80
GaziAntep	20	17	30	15	68	20	20	190	592	3.11
Hatay	25	21	30	15	68	20	20	200	592	2.96
Isparta	30	20	30	15	33	20	20	168	286	1.70
İstanbul	24	21	30	15	36	20	20	165	310	1.88
İzmir	18	15	30	15	40	20	20	159	349	2.20
K.Maraş	5	6	30	15	64	20	20	160	555	3.47
Kars	6	7	30	15	98	20	20	196	846	4.32
Kayseri	5	6	30	15	46	20	20	142	396	2.79
Konya	18	15	30	15	35	20	20	153	301	1.97
Malatya	34	23	30	15	70	20	20	212	606	2.87
Mardin	20	17	30	15	91	20	20	213	791	3.71
Muğla-B	14	12	30	15	38	20	20	149	332	2.22

Table G.1 Continued

	Distance to City Center (km.)	Step 1 Travel Dur. to Airport (min.) (*)	Step 2 Security Checks & Check-in (min.)	Step 3 Board . to Plane (min.)	Step 4 Dur. of Flight (min.)	Step 5 Land. of the plane, baggage claim (min.)	Step 6 Ride from airport to city (min.)	Total Av. Air Travel Dur. (min.)	Total Highway Travel Duration (min.)	Highway Travel / Air Travel Duration Ratio
Muğla-D	6	7	30	15	38	20	20	136	332	2.43
Muş	18	15	30	15	93	20	20	212	809	3.82
Nevşehir	30	20	30	15	42	20	20	177	362	2.05
Samsun	25	21	30	15	50	20	20	182	438	2.41
Siirt	14	12	30	15	100	20	20	211	867	4.11
Sinop	8	10	30	15	50	20	20	153	434	2.84
Sivas	23	20	30	15	55	20	20	183	480	2.62
Şanlıurfa	35	23	30	15	78	20	20	221	676	3.05
Tekirdağ	15	13	30	15	29	20	20	142	249	1.76
Tokat	20	17	30	15	50	20	20	172	433	2.52
Trabzon	6	7	30	15	74	20	20	172	642	3.73
Uşak	4	5	30	15	25	20	20	119	220	1.85
Van	8	10	30	15	109	20	20	212	945	4.47
Zafer A.	62	42	30	15	28	20	20	216	239	1.10
Or-Gi A.	22	19	30	15	63	20	20	189	545	2.89
Arithmetic means of 3 Big Cities	23	20								

(*) Average speed limit in city centers is 50 km/h, Motorways 90 km/h and highways 120 km/h

Between 0-10 kilometers	50 km/hr	Zafer Airport is located 390 km and Or-Gi airport is located 890 km. away from 3B Cities Authority)
Between 10-30 kilometers	70 km/hr	Data is obtained from DHMI (General Directorate of State Airports Statistics yearbook 2009
More than 30 kilometers	90 km/hr	

APPENDIX H

SOCIOECONOMIC CATEGORIZATION OF TURKISH CITIES

Table H.1 Socioeconomic Categorization of Turkish Cities

	Category	3 Big Cities	Tourism Cities	Anatolian Tigers	Rural Anatolia 1	Rural Anatolia 2	Rural Anatolia 3
Adana	AT	0	0	1	0	0	0
Adıyaman	RA3	0	0	0	0	0	1
Ağrı	RA3	0	0	0	0	0	1
Amasya	RA2	0	0	0	0	1	0
Ankara	3B	1	0	0	0	0	0
Antalya	TC	0	1	0	0	0	0
Balıkesir	AT	0	0	1	0	0	0
Bursa	AT	0	0	1	0	0	0
Çanakkale	RA1	0	0	0	1	0	0
Denizli	AT	0	0	1	0	0	0
Diyarbakır	RA3	0	0	0	0	0	1
Elazığ	RA3	0	0	0	0	0	1
Erzincan	RA3	0	0	0	0	0	1
Erzurum	RA3	0	0	0	0	0	1
Eskişehir	AT	0	0	1	0	0	0
GaziAntep	AT	0	0	1	0	0	0
Hatay	RA2	0	0	0	0	1	0
Isparta	RA1	0	0	0	1	0	0
İstanbul	3B	1	0	0	0	0	0
İzmir	3B	1	0	0	0	0	0
K.Maraş	AT	0	0	1	0	0	0
Kars	RA3	0	0	0	0	0	1
Kayseri	AT	0	0	1	0	0	0
Konya	AT	0	0	1	0	0	0
Malatya	RA3	0	0	0	0	0	1
Mardin	RA3	0	0	0	0	0	1
Muğla	TC	0	1	0	0	0	0
Muş	RA3	0	0	0	0	0	1
Nevşehir	RA2	0	0	0	0	1	0
Samsun	AT	0	0	1	0	0	0
Siirt	RA3	0	0	0	0	0	1
Sinop	RA2	0	0	0	0	1	0
Sivas	RA2	0	0	0	0	1	0
Şanlıurfa	RA3	0	0	0	0	0	1
Tekirdağ	RA1	0	0	0	1	0	0

Table H.1 Continued

	Category	3 Big Cities	Tourism Cities	Anatolian Tigers	Rural Anatolia 1	Rural Anatolia 2	Rural Anatolia 3
Tokat	RA2	0	0	0	0	1	0
Trabzon	AT	0	0	1	0	0	0
Uşak	RA1	0	0	0	1	0	0
Van	RA3	0	0	0	0	0	1
Kutahya	RA1	0	0	0	1	0	0
Afyon	RA1	0	0	0	1	0	0
Uşak	RA1	0	0	0	1	0	0
		0					
Ordu	RA3	0	0	0	0	0	1
Giresun	RA3	0	0	0	0	0	1

APPENDIX I

GLOBAL AIRLINERS AND TURKISH AIRLINES FINANCIAL DATA

Table I.1 Global Airliners And Turkish Airlines Financial Data

		2000	2001	2002	2003	2004
GLOBAL	Expenses (Billion USD)		319.00	311.00	323.00	376.00
	Income (Billion USD)		307.00	306.00	322.00	379.00
	Operating Profit (Billion USD)		-11.80	-4.80	-1.40	3.30
	RPK (Revenue Passenger Km) (Billion)	*2040.00*	*1905.00*	*1884.00*	*1410.00*	*2220.00*
THY	Domestic PAX	6.49E+06	5.19E+06	4.97E+06	5.03E+06	5.85E+06
	Domestic PAX*km (mil.)	3588.00	2876.00	2732.00	2790.00	3236.00
	Domestic Revenue (USD)					
	International PAX	5.54E+06	5.09E+06	5.41E+06	5.39E+06	6.14E+06
	International PAX*km(mil.)	13808.00	12803.00	13862.00	13322.00	15358.00
	International Revenue (USD)					
	Total PAX	1.20E+07	1.03E+07	1.04E+07	1.04E+07	1.20E+07
	Total PAX*km (mil.)	1.74E+04	1.57E+04	1.66E+04	1.61E+04	1.86E+04
	Total Revenue (USD)					
	Total Operational Income (USD)	1.43E+09	1.16E+09	1.33E+09	1.71E+09	2.08E+09
	Total Operational Cost (USD)	1.62E+09	1.28E+09	1.32E+09	1.58E+09	1.98E+09
	Total Operational Profit (USD)	-1.90E+08	-1.19E+08	1.18E+07	1.30E+08	1.06E+08
GLOBAL	Total Cost Per PAX (USD)					
	Total Cost Per PAX*km (USD)		0.17	0.17	0.23	0.17
	Total Profit Per PAX (USD)					
	Total Profit Per PAX*km (USD)		-0.01	0.00	0.00	0.00
THY	Total Cost Per PAX (USD)		124.18	126.83	151.87	164.72
	Total Operational Cost Per PAX*km (USD)		0.08	0.08	0.10	0.11
	Total Profit Per PAX (USD)		-11.63	1.13	12.51	8.86
	Total Profit Per PAX*km (USD)		-0.01	0.00	0.01	0.01
	Total Income Per PAX (USD)	118.74	112.56	127.96	164.38	173.58
	Total Operational & Managerial Spending (USD)		124.18	126.83	151.87	164.72
	Total Ticket Price Per Domestic PAX per km. (USD/km.)	0.00	0.00	0.00	0.00	0.00

Table I.1 Continued

		2005	2006	2007	2008	2009
GLOBAL	Expenses (Billion USD)	409.00	450.00	490.00	573.00	480.00
	Income (Billion USD)	413.00	465.00	510.00	564.00	479.00
	Operating Profit (Billion USD)	4.30	15.00	19.90	-8.90	-0.40
	RPK (Revenue Passenger Km) (Billion)	*2400.00*	*2604.00*	*2820.00*	*2820.00*	*2844.00*
THY	Domestic PAX	7.20E+06	8.91E+06	9.98E+06	1.11E+07	1.17E+07
	Domestic PAX*km (mil.)	4016.00	5213.00	5924.00	6417.00	6819.00
	Domestic Revenue (USD)					
	International PAX	6.94E+06	8.04E+06	9.65E+06	1.15E+07	1.34E+07
	International PAX*km(mil.)	17301.00	20170.00	24327.00	27848.00	33311.00
	International Revenue (USD)					
	Total PAX	1.41E+07	1.69E+07	1.96E+07	2.26E+07	2.51E+07
	Total PAX*km (mil.)	2.13E+04	2.54E+04	3.03E+04	3.43E+04	4.01E+04
	Total Revenue (USD)					
	Total Operational Income (USD)	2.34E+09	2.88E+09	4.12E+09	4.02E+09	4.60E+09
	Total Operational Cost (USD)	2.28E+09	2.31E+09	2.98E+09	3.06E+09	3.36E+09
	Total Operational Profit (USD)	6.29E+07	5.70E+08	1.14E+09	9.68E+08	1.24E+09
GLOBAL	Total Cost Per PAX (USD)					
	Total Cost Per PAX*km (USD)	0.17	0.17	0.17	0.20	0.17
	Total Profit Per PAX (USD)					
	Total Profit Per PAX*km (USD)	0.00	0.01	0.01	0.00	0.00
THY	Total Cost Per PAX (USD)	161.07	136.35	151.72	135.23	133.73
	Total Operational Cost Per PAX*km (USD)	0.11	0.09	0.10	0.09	0.08
	Total Profit Per PAX (USD)	4.45	33.66	57.94	42.83	49.47
	Total Profit Per PAX*km	0.00	0.02	0.04	0.03	0.03
	Total Income Per PAX (USD)	165.52	170.00	209.66	178.06	183.20
	Total Operational & Managerial Spending (USD)	161.07	136.35	151.72	135.23	133.73
	Total Ticket Price Per Domestic PAX per km.	0.00	0.00	0.00	0.00	0.00

The data is obtained from THY (http://www.thy.com , page last visited 01 November 2010) and IATA (http://www.iata.org, page last visited 01 November 2010)

APPENDIX J

NOMINAL GROSS DOMESTIC PRODUCT PER CAPITA OF TURKISH CITIES

Table J.1 Nominal Gross Domestic Product Per Capita of Turkish Cities

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Turkey	$2,941	$2,146	$3,529	$4,548	$5,802	$7,056	$7,643	$9,221	$10,285	$8,590
Adana	$3,286	$2,339	$3,895	$5,020	$6,404	$7,788	$8,436	$10,177	$11,352	$9,481
Adıyaman	$1,250	$918	$1,505	$1,940	$2,474	$3,009	$3,259	$3,932	$4,386	$3,663
Ağrı	$824	$568	$962	$1,239	$1,581	$1,923	$2,083	$2,513	$2,803	$2,341
Amasya	$2,049	$1,439	$2,412	$3,109	$3,966	$4,823	$5,225	$6,303	$7,031	$5,872
Ankara	$4,148	$2,752	$4,751	$6,123	$7,812	$9,500	$10,290	$12,415	$13,847	$11,565
Antalya	$2,911	$2,193	$3,550	$4,575	$5,836	$7,098	$7,688	$9,275	$10,346	$8,641
Balıkesir	$2,819	$2,005	$3,340	$4,305	$5,492	$6,679	$7,234	$8,728	$9,735	$8,130
Bursa	$3,491	$2,507	$4,156	$5,356	$6,833	$8,310	$9,001	$10,860	$12,113	$10,117
Çanakkale	$3,465	$2,335	$3,999	$5,154	$6,575	$7,996	$8,661	$10,449	$11,655	$9,734
Denizli	$2,807	$2,133	$3,438	$4,431	$5,652	$6,874	$7,446	$8,983	$10,020	$8,369
Diyarbakır	$1,691	$1,313	$2,094	$2,699	$3,444	$4,188	$4,536	$5,473	$6,104	$5,098
Elazığ	$2,253	$1,704	$2,753	$3,548	$4,526	$5,505	$5,963	$7,194	$8,024	$6,702
Erzincan	$1,530	$1,158	$1,871	$2,411	$3,075	$3,740	$4,051	$4,887	$5,451	$4,553
Erzurum	$1,452	$1,061	$1,744	$2,247	$2,867	$3,487	$3,777	$4,557	$5,082	$4,245
Eskişehir	$3,369	$2,513	$4,088	$5,268	$6,720	$8,173	$8,853	$10,680	$11,913	$9,950
GaziAntep	$2,102	$1,593	$2,570	$3,312	$4,226	$5,139	$5,567	$6,716	$7,491	$6,256
Hatay	$2,452	$1,757	$2,915	$3,757	$4,793	$5,829	$6,314	$7,617	$8,496	$7,096
Isparta	$2,107	$1,510	$2,505	$3,229	$4,119	$5,009	$5,426	$6,546	$7,301	$6,098
İstanbul	$4,416	$3,063	$5,168	$6,661	$8,497	$10,334	$11,193	$13,504	$15,063	$12,580
İzmir	$4,302	$3,215	$5,225	$6,733	$8,590	$10,446	$11,315	$13,652	$15,227	$12,717
K.Maraş	$1,930	$1,584	$2,460	$3,171	$4,045	$4,919	$5,329	$6,429	$7,171	$5,989
Kars	$1,134	$886	$1,409	$1,815	$2,316	$2,817	$3,051	$3,681	$4,105	$3,429
Kayseri	$2,308	$1,806	$2,870	$3,698	$4,718	$5,738	$6,215	$7,498	$8,363	$6,985
Konya	$2,241	$1,554	$2,623	$3,380	$4,312	$5,244	$5,680	$6,853	$7,644	$6,384
Malatya	$1,863	$1,417	$2,283	$2,942	$3,753	$4,564	$4,944	$5,964	$6,653	$5,556
Mardin	$1,151	$983	$1,499	$1,932	$2,464	$2,997	$3,246	$3,917	$4,369	$3,649

Table J.1 Continued

	2000	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Muğla	$4,253	$3,308	*$5,271*	*$6,794*	*$8,667*	*$10,540*	*$11,417*	*$13,774*	*$15,363*	*$12,831*
Nevşehir	$2,908	$2,117	*$3,485*	*$4,492*	*$5,730*	*$6,968*	*$7,548*	*$9,107*	*$10,157*	*$8,483*
Samsun	$2,325	$1,680	*$2,776*	*$3,578*	*$4,564*	*$5,551*	*$6,012*	*$7,254*	*$8,091*	*$6,757*
Siirt	$1,399	$1,111	*$1,753*	*$2,259*	*$2,882*	*$3,505*	*$3,796*	*$4,580*	*$5,109*	*$4,267*
Sinop	$1,879	$1,459	*$2,327*	*$2,999*	*$3,826*	*$4,653*	*$5,040*	*$6,081*	*$6,783*	*$5,665*
Sivas	$1,751	$1,399	*$2,201*	*$2,836*	*$3,618*	*$4,400*	*$4,766*	*$5,750*	*$6,413*	*$5,356*
Şanlıurfa	$1,301	$1,008	*$1,609*	*$2,074*	*$2,646*	*$3,218*	*$3,485*	*$4,205*	*$4,690*	*$3,917*
Tekirdağ	$3,412	$2,498	*$4,101*	*$5,286*	*$6,743*	*$8,200*	*$8,882*	*$10,716*	*$11,953*	*$9,983*
Tokat	$1,771	$1,370	*$2,189*	*$2,821*	*$3,599*	*$4,377*	*$4,741*	*$5,720*	*$6,380*	*$5,329*
Trabzon	$1,927	$1,506	*$2,394*	*$3,086*	*$3,937*	*$4,787*	*$5,186*	*$6,256*	*$6,978*	*$5,828*
Uşak	$2,047	$1,436	*$2,408*	*$3,104*	*$3,960*	*$4,815*	*$5,216*	*$6,293*	*$7,019*	*$5,862*
Van	$1,118	$859	*$1,377*	*$1,775*	*$2,264*	*$2,753*	*$2,983*	*$3,598*	*$4,014*	*$3,352*
Kutahya	$2,256	$1,805	*$2,838*	*$3,657*	*$4,665*	*$5,674*	*$6,146*	*$7,415*	*$8,270*	*$6,907*
Afyon	$1,727	$1,263	*$2,074*	*$2,673*	*$3,411*	*$4,148*	*$4,493*	*$5,420*	*$6,046*	*$5,049*
Uşak	$2,047	$1,436	*$2,408*	*$3,104*	*$3,960*	*$4,815*	*$5,216*	*$6,293*	*$7,019*	*$5,862*
Ordu	$1,375	$1,064	*$1,700*	*$2,191*	*$2,795*	*$3,399*	*$3,681*	*$4,441*	*$4,954*	*$4,137*
Giresun	$1,874	$1,443	*$2,311*	*$2,978*	*$3,799*	*$4,621*	*$5,005*	*$6,038*	*$6,735*	*$5,625*

The data shown in italics is approximation. Details can be found in Chapter 4.The information is obtained from Turkish Statistics Institute (http://www.tuik.gov.tr, page last visited 01 November 2010).

APPENDIX K

NOMINAL EXPORT AMOUNTS OF TURKISH CITIES

Table K.1 Nominal Export Amounts Of Turkish Cities

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Adana	378,376	425,102	461,040	565,281	816,249	883,833	958,987	1,146,339	1,274,081	1,134,975
Adıyaman	2,860	5,165	8,097	12,079	20,978	22,207	24,336	27,469	58,466	58,091
Ağrı	1,428	3,112	3,153	8,165	21,073	28,219	26,113	26,859	45,979	44,336
Amasya	2,284	877	1,312	5,097	12,136	17,758	8,947	20,760	19,758	21,629
Ankara	1,513,187	1,629,845	1,515,106	1,979,820	2,227,510	2,645,499	3,596,924	4,221,009	5,362,594	4,909,196
Antalya	73,697	136,520	165,989	324,990	457,829	396,315	437,115	640,287	706,543	654,391
Balıkesir	65,037	79,067	90,166	121,156	157,559	228,333	228,211	316,077	347,244	364,675
Bursa	2,523,149	2,980,868	3,456,516	4,354,024	5,421,397	5,732,086	7,350,590	9,048,668	11,103,935	9,057,157
Çanakkale	31,803	39,527	52,616	62,700	68,561	62,470	102,590	95,313	152,920	85,955
Denizli	447,335	552,022	680,541	866,083	1,196,291	1,415,355	1,635,422	2,001,071	2,192,298	1,587,336
Diyarbakır	6,540	7,895	6,811	11,960	34,725	57,349	66,877	83,403	89,191	115,848
Elazığ	16,371	7,429	24,328	34,254	13,363	48,280	68,265	57,779	44,727	30,061
Erzincan	451	560	364	886	361	982	583	1,177	5,582	9,747
Erzurum	6,135	7,065	7,070	9,854	14,171	20,896	20,546	26,243	34,978	24,255
Eskişehir	134,056	145,444	151,065	179,607	214,078	268,761	352,089	506,392	606,684	557,754
GaziAntep	510,746	599,598	619,536	866,153	1,295,292	1,652,554	1,857,722	2,403,363	3,251,891	2,952,488
Hatay	317,235	353,497	349,548	462,282	654,914	745,358	933,919	1,185,949	1,748,240	1,416,898
Isparta	38,483	46,369	57,576	70,027	79,147	81,343	82,604	92,882	87,391	74,618
İstanbul	14,597,856	17,848,389	20,970,063	27,599,988	36,834,410	41,716,339	47,012,604	59,278,268	73,127,892	55,541,325
İzmir	2,496,123	2,740,576	2,777,767	3,473,936	4,110,487	4,645,381	5,448,572	6,388,981	7,758,160	6,117,777
K.Maraş	126,780	129,768	110,305	138,732	205,874	229,108	286,321	324,613	374,997	430,773
Kars	1,334	1,590	807	2,358	3,277	2,694	1,945	57,363	344	236
Kayseri	270,553	319,191	351,569	465,104	639,617	702,969	751,660	973,209	1,129,769	963,223
Konya	83,803	107,612	129,959	179,039	275,556	419,985	493,532	688,723	856,083	734,944
Malatya	43,810	55,292	71,618	89,738	127,124	121,620	151,417	179,017	250,486	221,160
Mardin	67,482	60,432	23,405	39,282	73,330	171,436	191,294	316,632	430,028	549,798
Muğla	13,489	24,752	39,624	58,541	79,835	95,764	122,938	189,054	247,135	193,557
Muş	0	37	70	0	0	41	2,632	1,094	489	6,642
Nevşehir	5,200	6,097	7,540	8,787	10,545	12,826	19,031	15,566	14,485	20,688
Samsun	32,465	38,273	37,715	55,696	108,817	118,872	158,329	216,150	445,646	304,213
Siirt	247	351	360	664	2,465	5,785	1,010	4,009	903	921
Sinop	1,416	1,964	3,729	3,608	8,355	11,293	12,288	17,899	16,202	20,128
Sivas	3,606	5,116	8,463	9,647	12,866	19,447	21,701	35,123	40,489	37,391
Şanlıurfa	24,869	21,202	6,967	10,200	14,691	32,392	45,922	85,982	140,363	128,431
Tekirdağ	203,000	239,074	298,731	347,296	365,354	369,256	441,775	525,206	526,384	483,255

Table K.1 Continued

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tokat	*2,464*	3,514	5,747	6,665	7,158	8,209	10,984	16,461	20,932	21,719
Trabzon	*165,266*	206,408	234,075	329,833	560,096	965,882	728,710	890,900	907,693	815,701
Uşak	*41,236*	46,367	47,284	61,760	83,175	94,591	111,253	114,935	114,783	96,701
Van	*1,376*	1,742	1,427	2,839	7,462	13,415	15,306	9,535	11,995	17,341

Kutahya	*30,384*	37,955	42,622	60,669	84,963	92,532	89,837	89,087	112,937	101,758
Afyon	*42,444*	49,597	55,184	71,057	89,817	110,393	149,414	189,640	225,397	208,609
Uşak	*41,236*	46,367	47,284	61,760	83,175	94,591	111,253	114,935	114,783	96,701
Ordu	*150,816*	142,773	110,499	118,645	268,999	353,286	280,561	284,870	314,404	205,150
Giresun	*54,894*	56,436	64,659	61,063	69,115	117,225	102,885	100,306	110,235	101,741

The data shown in italics is approximation. Details can be found in Chapter 4.The information is obtained from Turkish Statistics Institute (http://www.tuik.gov.tr, page last visited 01 November 2010).

APPENDIX L

NUMBER OF EXPORT MAKING COMPANIES OF TURKISH CITIES

Table L.1 Number of Export Making Companies of Turkish Cities

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Adana	*341*	391	417	486	566	659	737	800	812	839
Adıyaman	*3*	6	8	12	14	17	18	26	31	35
Ağrı	*26*	28	23	27	44	43	38	45	44	43
Amasya	*9*	11	10	18	20	21	27	25	25	32
Ankara	*1,451*	1,640	1,783	2,005	2,359	2,603	2,734	2,952	3,225	3,341
Antalya	*293*	335	413	486	553	589	592	684	711	710
Balıkesir	*112*	122	145	169	177	203	190	192	192	210
Bursa	*1,364*	1,518	1,720	1,964	2,223	2,374	2,572	2,939	2,804	2,901
Çanakkale	*43*	46	46	57	60	63	54	72	63	71
Denizli	*430*	463	502	570	636	689	724	780	732	760
Diyarbakır	*8*	18	17	32	56	83	84	64	84	106
Elazığ	*15*	20	20	29	34	42	55	53	51	62
Erzincan	*4*	5	5	5	4	4	5	5	10	11
Erzurum	*31*	32	26	24	35	34	28	27	29	37
Eskişehir	*138*	148	159	168	195	218	224	243	241	242
GaziAntep	*480*	537	578	639	713	821	857	931	976	1,046
Hatay	*395*	421	490	488	519	570	597	649	667	659
Isparta	*54*	57	63	70	68	74	74	76	78	82
İstanbul	*15,006*	16,066	17,588	19,662	21,679	22,896	23,942	26,067	25,804	25,602
İzmir	*2,569*	2,681	2,979	3,333	3,639	3,717	3,844	4,204	3,923	3,692
K.Maraş	*104*	112	119	134	152	158	167	164	177	185
Kars	*6*	6	7	7	5	5	8	6	3	5
Kayseri	*304*	338	387	458	533	579	612	677	618	645
Konya	*405*	462	520	558	627	679	779	852	919	975
Malatya	*73*	80	59	74	97	114	108	119	119	140
Mardin	*66*	77	58	95	98	99	124	127	139	177
Muğla	*83*	95	133	163	196	175	169	214	218	205
Muş	*2*	2	3	0	0	1	4	5	3	5
Nevşehir	*40*	40	39	49	54	62	54	58	47	43
Samsun	*87*	99	119	117	136	161	150	174	210	209
Siirt	*5*	5	5	6	9	8	6	8	4	6
Sinop	*16*	16	15	13	10	12	14	10	13	19
Sivas	*26*	29	27	25	33	39	47	48	52	52
Şanlıurfa	*40*	48	41	44	47	67	85	80	92	123
Tekirdağ	*146*	160	172	171	183	218	236	286	292	283

Table L.1 Continued

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tokat	*11*	13	22	28	28	32	26	30	34	33
Trabzon	*147*	152	164	168	154	144	168	199	229	200
Uşak	*95*	99	106	106	134	151	153	146	136	131
Van	*17*	20	22	22	49	47	56	43	34	45

Kutahya	*36*	39	43	57	61	53	61	61	74	66
Afyon	*85*	98	106	125	146	176	178	199	201	213
Uşak	*95*	99	106	106	134	151	153	146	136	131
Ordu	*66*	65	52	57	43	46	42	47	58	53
Giresun	*28*	28	33	27	26	27	29	27	30	31

The data shown in italics is approximation. Details can be found in Chapter 4.The information is obtained from Turkish Statistics Institute (http://www.tuik.gov.tr, page last visited 01 November 2010).

APPENDIX M

TOURISTIC BED CAPACITIES OF TURKISH CITIES

Table M.1 Touristic Bed Capacities Of Turkish Cities

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Adana	3,308	3,652	3,621	3,673	3,641	3,003	3,780	4,602	6,010	6,310
Adıyaman	1,300	1,485	1,292	685	827	824	788	788	832	780
Ağrı	1,156	1,152	1,188	1,116	1,312	954	703	805	609	548
Amasya	673	673	503	451	511	736	791	568	816	832
Ankara	17,900	17,346	18,566	19,150	20,978	22,917	22,632	22,879	24,137	24,830
Antalya	188,613	202,014	218,173	248,129	284,472	325,788	340,566	337,843	346,517	364,062
Balıkesir	13,214	13,411	12,379	12,426	11,207	10,916	11,121	12,307	11,924	11,781
Bursa	10,011	10,759	11,219	12,118	10,978	10,823	9,562	9,162	9,303	9,224
Çanakkale	5,225	5,670	6,115	6,285	6,416	6,064	5,400	5,191	5,095	5,081
Denizli	4,237	5,114	5,604	5,258	5,647	5,693	5,401	5,714	6,030	6,229
Diyarbakır	2,110	2,119	2,013	1,792	1,792	1,812	1,818	1,851	2,173	2,180
Elazığ	240	240	960	1,413	1,403	1,264	877	877	877	948
Erzincan	308	404	404	438	436	352	432	398	390	399
Erzurum	2,278	2,737	2,673	2,713	2,781	3,137	3,196	2,876	2,955	3,030
Eskişehir	860	860	799	1,004	1,004	1,678	1,678	1,678	2,061	2,194
GaziAntep	2,897	3,362	3,497	2,911	3,371	4,351	4,281	5,078	5,162	5,414
Hatay	2,103	2,301	2,688	2,701	2,718	2,948	3,013	2,962	3,228	3,353
Isparta	914	914	944	1,118	1,259	2,073	1,877	1,877	1,877	1,984
İstanbul	67,974	72,572	74,395	79,187	81,742	75,718	78,098	79,065	85,913	87,906
İzmir	35,496	36,569	35,385	36,142	34,704	38,950	36,494	40,744	40,761	41,346
K.Maraş	868	682	686	557	557	557	701	828	775	765
Kars	1,539	1,612	1,693	1,472	1,557	2,758	2,805	2,623	1,411	1,397
Kayseri	2,450	2,658	2,658	2,237	2,027	2,259	2,800	3,251	3,787	3,936
Konya	3,028	2,972	2,585	2,627	2,968	3,215	4,023	4,224	4,497	4,660
Malatya	868	868	1,016	885	1,123	1,189	1,002	1,408	1,236	1,277
Mardin	824	936	1,137	1,047	996	806	1,132	1,252	1,410	1,475
Muğla	110,280	113,520	117,957	125,216	131,874	129,390	136,056	130,967	134,341	137,014
Muş	364	478	298	434	434	434	470	472	348	346
Nevşehir	9,081	9,664	9,397	9,879	10,418	10,459	9,936	11,972	11,546	11,820
Samsun	1,258	1,298	908	1,453	1,526	1,426	1,491	1,164	856	811
Siirt	78	78	78	78	158	80	80	324	324	351
Sinop	592	620	620	548	449	449	178	406	737	753
Sivas	780	820	820	827	827	764	689	732	1,200	1,247
Şanlıurfa	591	591	747	912	1,845	1,940	1,812	1,669	2,351	2,547
Tekirdağ	2,541	2,207	1,712	1,122	1,062	875	1,131	1,624	2,079	2,028

Table M.1 Continued

Tokat	545	593	589	485	555	882	957	406	887	925
Trabzon	3,087	3,034	2,999	2,211	2,937	4,364	5,128	4,762	4,418	4,566
Uşak	425	522	573	573	648	648	599	645	869	918
Van	1,705	1,941	1,909	1,710	1,612	1,689	1,478	1,296	1,292	1,246
Kutahya	1,116	1,116	1014	822	822	892	1,718	1,526	1,934	2,025
Afyon	3,599	3558	3613	4,107	2,495	3,737	5,217	4,902	5,970	6,233
Uşak	425	522	573	573	648	648	599	645	869	918
Ordu	897	1131	1225	924	1,188	1,351	1,239	1,412	1,257	1,297
Giresun	757	775	710	926	926	1,178	1,259	1,175	1,184	1,231

The information is obtained from Turkish Ministry of Tourism and Culture (http://www.turizm.gov.tr, page last visited 01 November 2010).

APPENDIX N

FINAL DATA

Table N.1 Final Data

NO	Airport Case	Passenger Number	Population	Urban Population	GDPPC (USD)	Gravity Model Coeff. (Ea.2/Km 2)	Airline Profit. (USD /PAX)	Highway vs. Air Travel Duration	Taxes (1= YES)	Export Amount (USD)	Num. of Export Comp. (Ea.)	Bed Capa. (Ea.)
1	Adıyaman_2005	6,864	594,491	331,884	2,942	1.08E+07	4	3.54	0	22,207	17	824
2	Adıyaman_2006	37,669	588,627	330,473	3,199	1.09E+07	34	3.54	0	24,336	18	788
3	Adıyaman_2007	48,621	582,762	329,060	3,919	1.10E+07	58	3.54	0	27,469	26	788
4	Adıyaman_2008	86,280	585,067	329,965	4,425	1.12E+07	43	3.54	0	58,466	31	832
5	Adıyaman_2009	85,112	588,475	338,617	3,625	1.15E+07	49	3.54	0	58,091	35	780
6	Ağrı_2001	8,538	529,049	256,603	568	5.41E+06	-12	4.20	1	3,112	28	1,152
7	Ağrı_2002	9,312	529,354	260,897	916	5.55E+06	1	4.20	1	3,153	23	1,188
8	Ağrı_2003	8,307	529,659	265,191	1,204	5.70E+06	13	4.20	1	8,165	27	1,116
9	Ağrı_2004	9,576	529,964	269,485	1,533	5.84E+06	9	4.20	0	21,073	44	1,312
10	Ağrı_2005	12,736	530,269	273,779	1,880	5.98E+06	4	4.20	0	28,219	43	954
11	Ağrı_2006	22,884	530,574	278,073	2,044	6.13E+06	34	4.20	0	26,113	38	703
12	Ağrı_2007	42,621	530,879	282,361	2,504	6.27E+06	58	4.20	0	26,859	45	805
13	Ağrı_2008	60,360	532,180	265,714	2,828	6.37E+06	43	4.20	0	45,979	44	609
14	Ağrı_2009	14,169	537,665	269,147	2,316	6.56E+06	49	4.20	0	44,336	43	548
15	Çanakkale_2007	41,079	476,128	247,443	10,413	8.03E+07	58	1.97	0	95,313	72	5,191
16	Çanakkale_2008	21,259	474,791	248,008	11,759	8.10E+07	43	1.97	0	152,920	63	5,095
17	Çanakkale_2009	19,207	477,735	255,220	9,632	8.30E+07	49	1.97	0	85,955	71	5,081
18	Denizli-Çardak_2001	35,397	858,215	420,605	2,133	9.52E+07	-12	1.22	1	552,022	463	5,114
19	Denizli-Çardak_2002	34,600	866,401	427,296	3,273	9.80E+07	1	1.22	1	680,541	502	5,604
20	Denizli-Çardak_2003	37,741	874,587	433,987	4,305	1.01E+08	13	1.22	1	866,083	570	5,258
21	Denizli-Çardak_2004	46,119	882,773	440,678	5,481	1.04E+08	9	1.22	0	1,196,291	636	5,647
22	Denizli-Çardak_2005	66,276	890,959	447,369	6,721	1.07E+08	4	1.22	0	1,415,355	689	5,693
23	Denizli-Çardak_2006	129,694	899,145	454,060	7,307	1.10E+08	34	1.22	0	1,635,422	724	5,401
24	Diyarbakır_2001	222,221	1,376,709	823,078	1,313	1.68E+07	-12	4.07	1	7,895	18	2,119
25	Diyarbakır_2002	185,262	1,390,710	828,464	1,994	1.74E+07	1	4.07	1	6,811	17	2,013
26	Diyarbakır_2003	211,750	1,404,711	833,850	2,623	1.80E+07	13	4.07	1	11,960	32	1,792
27	Diyarbakır_2004	495,942	1,418,712	839,236	3,339	1.86E+07	9	4.07	0	34,725	56	1,792
28	Diyarbakır_2005	676,098	1,432,713	844,622	4,095	1.92E+07	4	4.07	0	57,349	83	1,812

Table N.1 Continued

NO	Airport Case	Passenger Number	Population	Urban Population	GDPP C (USD)	Gravity Model Coeff. (Ea.2/Km2)	Airline Profit. (USD /PAX)	Highway vs. Air Travel Duration	Taxes (1= YES)	Export Amount (USD)	Number of Export Comp. (Ea.)	Bed Capa. (Ea.)
29	Diyarbakır_2006	843,852	1,446,714	850,008	4,451	1.98E+07	34	4.07	0	66,877	84	1,818
30	Diyarbakır_2007	895,625	1,460,714	855,389	5,454	2.05E+07	58	4.07	0	83,403	64	1,851
31	Diyarbakır_2008	967,088	1,492,828	1,051,511	6,159	2.12E+07	43	4.07	0	89,191	84	2,173
32	Diyarbakır_2009	1,060,381	1,515,011	1,079,160	5,045	2.19E+07	49	4.07	0	115,848	106	2,180
33	Elazığ_2001	56,593	565,565	367,917	1,704	9.18E+06	-12	3.61	1	7,429	20	240
34	Elazığ_2002	46,238	561,514	371,560	2,621	9.34E+06	1	3.61	1	24,328	20	960
35	Elazığ_2003	40,709	557,463	375,203	3,448	9.49E+06	13	3.61	1	34,254	29	1,413
36	Elazığ_2004	39,007	553,412	378,846	4,389	9.64E+06	9	3.61	0	13,363	34	1,403
37	Elazığ_2005	45,303	549,361	382,489	5,382	9.79E+06	4	3.61	0	48,280	42	1,264
38	Elazığ_2006	69,578	545,310	386,132	5,851	9.93E+06	34	3.61	0	68,265	55	877
39	Elazığ_2007	119,877	541,258	389,774	7,169	1.01E+07	58	3.61	0	57,779	53	877
40	Elazığ_2008	135,293	547,562	384,034	8,095	1.03E+07	43	3.61	0	44,727	51	877
41	Elazığ_2009	344,844	550,667	392,722	6,631	1.06E+07	49	3.61	0	30,061	62	948
42	Erzincan_2001	12,023	302,084	163,954	1,158	6.21E+06	-12	3.48	1	560	5	404
43	Erzincan_2002	6,712	287,327	155,702	1,781	6.05E+06	1	3.48	1	364	5	404
44	Erzincan_2003	8,377	272,570	147,450	2,342	5.88E+06	13	3.48	1	886	5	438
45	Erzincan_2004	10,253	257,813	139,198	2,982	5.70E+06	9	3.48	0	361	4	436
46	Erzincan_2005	21,097	243,056	130,946	3,657	5.50E+06	4	3.48	0	982	4	352
47	Erzincan_2006	41,326	228,299	122,694	3,975	5.28E+06	34	3.48	0	583	5	432
48	Erzincan_2007	64,681	213,538	114,437	4,871	5.05E+06	58	3.48	0	1,177	5	398
49	Erzincan_2008	91,540	210,645	113,231	5,500	5.05E+06	43	3.48	0	5,582	10	390
50	Erzincan_2009	127,030	213,288	118,695	4,505	5.21E+06	49	3.48	0	9,747	11	399
51	Erzurum_2001	103,917	915,611	549,839	1,061	1.27E+07	-12	3.83	1	7,065	32	2,737
52	Erzurum_2002	94,610	893,833	539,127	1,660	1.27E+07	1	3.83	1	7,070	26	2,673
53	Erzurum_2003	104,821	872,055	528,415	2,184	1.27E+07	13	3.83	1	9,854	24	2,713
54	Erzurum_2004	217,984	850,277	517,703	2,780	1.27E+07	9	3.83	0	14,171	35	2,781
55	Erzurum_2005	303,751	828,499	506,991	3,409	1.27E+07	4	3.83	0	20,896	34	3,137
56	Erzurum_2006	453,013	806,721	496,279	3,706	1.26E+07	34	3.83	0	20,546	28	3,196
57	Erzurum_2007	591,105	784,941	485,563	4,541	1.26E+07	58	3.83	0	26,243	27	2,876
58	Erzurum_2008	527,598	774,967	485,107	5,128	1.26E+07	43	3.83	0	34,978	29	2,955
59	Erzurum_2009	599,017	774,207	491,038	4,200	1.28E+07	49	3.83	0	24,255	37	3,030
60	Eskişehir_2007	15,504	724,849	625,453	10,680	1.51E+08	58	1.80	0	506,392	243	1,678
61	Eskişehir_2008	45,477	741,739	653,663	11,913	1.57E+08	43	1.80	0	606,684	241	2,061
62	Eskişehir_2009	78,323	755,427	669,444	9,950	1.63E+08	49	1.80	0	557,754	242	2,194
63	GaziAntep_2001	212,273	1,324,503	1,056,754	1,593	2.65E+07	-12	3.11	1	599,598	537	3,362
64	GaziAntep_2002	271,975	1,363,757	1,104,382	2,447	2.80E+07	1	3.11	1	619,536	578	3,497
65	GaziAntep_2003	223,303	1,403,011	1,152,010	3,219	2.94E+07	13	3.11	1	866,153	639	2,911
66	GaziAntep_2004	411,213	1,442,265	1,199,638	4,097	3.09E+07	9	3.11	0	1,295,292	713	3,371

Table N.1 Continued

NO	Airport Case	Passenger Number	Population	Urban Population	GDPP C (USD)	Gravity Model Coeff. (Ea.2/Km2)	Airline Profit. (USD /PAX)	Highway vs. Air Travel Duration	Taxes (1= YES)	Export Amount (USD)	Number of Export Comp. (Ea.)	Bed Capa. (Ea.)
67	GaziAntep_2005	210,539	1,481,519	1,247,266	5,025	3.25E+07	4	3.11	0	1,652,554	821	4,351
68	Isparta-S.Demirel_2006	38,258	433,251	278,113	5,324	3.63E+07	34	1.70	0	82,604	74	1,877
69	Isparta-S.Demirel_2007	47,564	419,845	274,204	6,523	3.60E+07	58	1.70	0	92,882	76	1,877
70	Isparta-S.Demirel_2008	15,053	407,463	264,855	7,366	3.54E+07	43	1.70	0	87,391	78	1,877
71	Isparta-S.Demirel_2009	16,461	420,796	280,154	6,034	3.72E+07	49	1.70	0	74,618	82	1,984
72	K.Maraş_2005	6,005	1,003,834	570,807	4,810	2.64E+07	4	3.47	0	229,108	158	557
73	K.Maraş_2006	33,787	1,004,124	577,767	5,229	2.70E+07	34	3.47	0	286,321	167	701
74	K.Maraş_2007	46,861	1,004,414	584,726	6,407	2.76E+07	58	3.47	0	324,613	164	828
75	K.Maraş_2008	68,167	1,029,298	598,471	7,234	2.87E+07	43	3.47	0	374,997	177	775
76	K.Maraş_2009	81,420	1,037,491	605,531	5,926	2.95E+07	49	3.47	0	430,773	185	765
77	Kars_2001	51,743	323,186	141,086	886	3.20E+06	-12	4.32	1	1,590	6	1,612
78	Kars_2002	46,941	321,356	140,027	1,341	3.27E+06	1	4.32	1	807	7	1,693
79	Kars_2003	54,312	319,526	138,968	1,764	3.33E+06	13	4.32	1	2,358	7	1,472
80	Kars_2004	86,281	317,696	137,909	2,246	3.39E+06	9	4.32	0	3,277	5	1,557
81	Kars_2005	162,158	315,866	136,850	2,754	3.46E+06	4	4.32	0	2,694	5	2,758
82	Kars_2006	270,052	314,036	135,791	2,994	3.52E+06	34	4.32	0	1,945	8	2,805
83	Kars_2007	95,421	312,205	134,726	3,668	3.58E+06	58	4.32	0	57,363	6	2,623
84	Kars_2008	269,095	312,128	130,625	4,142	3.62E+06	43	4.32	0	344	3	1,411
85	Kars_2009	288,008	306,536	126,127	3,393	3.63E+06	49	4.32	0	236	5	1,397
86	Kayseri_2001	180,802	1,075,383	755,626	1,806	6.69E+07	-12	2.79	1	319,191	338	2,658
87	Kayseri_2002	242,134	1,090,334	778,898	2,732	6.93E+07	1	2.79	1	351,569	387	2,658
88	Kayseri_2003	324,959	1,105,285	802,170	3,593	7.17E+07	13	2.79	1	465,104	458	2,237
89	Kayseri_2004	467,326	1,120,236	825,442	4,575	7.42E+07	9	2.79	0	639,617	533	2,027
90	Kayseri_2005	541,956	1,135,187	848,714	5,610	7.67E+07	4	2.79	0	702,969	579	2,259
91	Kayseri_2006	681,107	1,150,138	871,986	6,099	7.92E+07	34	2.79	0	751,660	612	2,800
92	Kayseri_2007	765,306	1,165,088	895,253	7,472	8.18E+07	58	2.79	0	973,209	677	3,251
93	Kayseri_2008	674,833	1,184,386	1,001,449	8,438	8.44E+07	43	2.79	0	1,129,769	618	3,787
94	Kayseri_2009	778,639	1,205,872	1,027,279	6,912	8.77E+07	49	2.79	0	963,223	645	3,936
95	Konya_2001	82,991	2,158,869	1,311,607	1,554	2.07E+08	-12	1.97	1	107,612	462	2,972
96	Konya_2002	58,112	2,125,572	1,328,397	2,497	2.08E+08	1	1.97	1	129,959	520	2,585
97	Konya_2003	78,162	2,092,275	1,345,187	3,284	2.09E+08	13	1.97	1	179,039	558	2,627
98	Konya_2004	94,678	2,058,978	1,361,977	4,181	2.09E+08	9	1.97	0	275,556	627	2,968
99	Konya_2005	167,252	2,025,681	1,378,767	5,127	2.10E+08	4	1.97	0	419,985	679	3,215
100	Konya_2006	262,561	1,992,384	1,395,557	5,574	2.11E+08	34	1.97	0	493,532	779	4,023
101	Konya_2007	248,070	1,959,082	1,412,343	6,829	2.11E+08	58	1.97	0	688,723	852	4,224
102	Konya_2008	266,143	1,969,868	1,423,546	7,711	2.15E+08	43	1.97	0	856,083	919	4,497
103	Konya_2009	301,724	1,992,675	1,450,682	6,317	2.22E+08	49	1.97	0	734,944	975	4,660
104	Malatya_2001	84,193	834,859	494,407	1,417	1.68E+07	-12	2.87	1	55,292	80	868

Table N.1 Continued

NO	Airport Case	Passenger Number	Population	Urban Population	GDPPC (USD)	Gravity Model Coeff. (Ea.2/Km2)	Airline Profit. (USD /PAX)	Highway vs. Air Travel Duration	Taxes (1= YES)	Export Amount (USD)	Number of Export Comp. (Ea.)	Bed Capa. (Ea.)
105	Malatya_2002	87,512	816,060	489,101	2,173	1.68E+07	1	2.87	1	71,618	59	1,016
106	Malatya_2003	89,545	797,261	483,795	2,858	1.68E+07	13	2.87	1	89,738	74	885
107	Malatya_2004	140,230	778,462	478,489	3,639	1.68E+07	9	2.87	0	127,124	97	1,123
108	Malatya_2005	304,565	759,663	473,183	4,462	1.67E+07	4	2.87	0	121,620	114	1,189
109	Malatya_2006	406,425	740,864	467,877	4,851	1.67E+07	34	2.87	0	151,417	108	1,002
110	Malatya_2007	421,444	722,065	462,569	5,944	1.66E+07	58	2.87	0	179,017	119	1,408
111	Malatya_2008	463,817	733,789	492,411	6,712	1.71E+07	43	2.87	0	250,486	119	1,236
112	Malatya_2009	462,884	736,884	468,310	5,498	1.75E+07	49	2.87	0	221,160	140	1,277
113	Mardin_2001	31,895	710,910	396,587	983	7.61E+06	-12	3.71	1	60,432	77	936
114	Mardin_2002	25,930	716,722	401,925	1,427	7.87E+06	1	3.71	1	23,405	58	1,137
115	Mardin_2003	19,538	722,534	407,263	1,877	8.12E+06	13	3.71	1	39,282	95	1,047
116	Mardin_2004	22,060	728,346	412,601	2,389	8.38E+06	9	3.71	0	73,330	98	996
117	Mardin_2005	41,256	734,158	417,939	2,930	8.64E+06	4	3.71	0	171,436	99	806
118	Mardin_2006	115,626	739,970	423,277	3,186	8.91E+06	34	3.71	0	191,294	124	1,132
119	Mardin_2007	191,383	745,778	428,611	3,903	9.18E+06	58	3.71	0	316,632	127	1,252
120	Mardin_2008	192,764	750,697	422,537	4,407	9.36E+06	43	3.71	0	430,028	139	1,410
121	Mardin_2009	233,288	737,852	422,284	3,610	9.38E+06	49	3.71	0	549,798	177	1,475
122	Muş_2001	16,834	446,777	157,133	578	4.74E+06	-12	3.82	1	37	2	478
123	Muş_2002	17,300	439,900	154,763	867	4.79E+06	1	3.82	1	70	3	298
124	Muş_2003	18,142	433,023	152,393	1,140	4.83E+06	13	3.82	1	0	0	434
125	Muş_2004	34,227	426,146	150,023	1,451	4.86E+06	9	3.82	0	0	0	434
126	Muş_2005	28,362	419,269	147,653	1,780	4.90E+06	4	3.82	0	41	1	434
127	Muş_2006	35,984	412,392	145,283	1,935	4.93E+06	34	3.82	0	2,632	4	470
128	Muş_2007	23,905	405,509	142,913	2,371	4.96E+06	58	3.82	0	1,094	5	472
129	Muş_2008	88,875	404,309	138,089	2,677	5.01E+06	43	3.82	0	489	3	348
130	Muş_2009	115,795	404,484	139,332	2,193	5.11E+06	49	3.82	0	6,642	5	346
131	Nevşehir_2001	19,430	305,649	137,740	2,117	2.41E+07	-12	2.05	1	6,097	40	9,664
132	Nevşehir_2002	16,703	301,384	138,957	3,318	2.43E+07	1	2.05	1	7,540	39	9,397
133	Nevşehir_2003	15,781	297,119	140,174	4,364	2.44E+07	13	2.05	1	8,787	49	9,879
134	Nevşehir_2004	9,932	292,854	141,391	5,556	2.45E+07	9	2.05	0	10,545	54	10,418
135	Nevşehir_2005	17,126	288,589	142,608	6,814	2.46E+07	4	2.05	0	12,826	62	10,459
136	Nevşehir_2006	27,832	284,324	143,825	7,407	2.47E+07	34	2.05	0	19,031	54	9,936
137	Nevşehir_2007	54,054	280,058	145,037	9,075	2.48E+07	58	2.05	0	15,566	58	11,972
138	Nevşehir_2008	100,762	281,699	146,349	10,248	2.54E+07	43	2.05	0	14,485	47	11,546
139	Nevşehir_2009	122,753	284,025	151,689	8,394	2.61E+07	49	2.05	0	20,688	43	11,820
140	Samsun-Çarşamba_2001	174,638	1,211,969	648,091	1,680	5.60E+07	-12	2.41	1	38,273	99	1,298
141	Samsun-Çarşamba_2002	171,648	1,214,801	660,928	2,643	5.75E+07	1	2.41	1	37,715	119	908
142	Samsun-Çarşamba_2003	175,300	1,217,633	673,765	3,476	5.90E+07	13	2.41	1	55,696	117	1,453

Table N.1 Continued

NO	Airport Case	Passenger Number	Population	Urban Population	GDPP C (USD)	Gravity Model Coeff. (Ea.2/Km2)	Airline Profit. (USD /PAX)	Highway vs. Air Travel Duration	Taxes (1= YES)	Export Amount (USD)	Number of Export Comp. (Ea.)	Bed Capa. (Ea.)
143	Samsun-Çarşamba_2004	294,710	1,220,465	686,602	4,425	6.05E+07	9	2.41	0	108,817	136	1,526
144	Samsun-Çarşamba_2005	384,434	1,223,297	699,439	5,427	6.20E+07	4	2.41	0	118,872	161	1,426
145	Samsun-Çarşamba_2006	483,089	1,226,129	712,276	5,900	6.35E+07	34	2.41	0	158,329	150	1,491
146	Samsun-Çarşamba_2007	555,796	1,228,959	725,111	7,229	6.50E+07	58	2.41	0	216,150	174	1,164
147	Samsun-Çarşamba_2008	604,387	1,233,677	776,385	8,163	6.62E+07	43	2.41	0	445,646	210	856
148	Samsun-Çarşamba_2009	866,862	1,250,076	802,011	6,686	6.84E+07	49	2.41	0	304,213	209	811
149	Siirt_2005	11,994	283,571	167,987	3,427	2.82E+06	4	4.11	0	5,785	8	80
150	Siirt_2006	18,097	287,550	170,880	3,725	2.92E+06	34	4.11	0	1,010	6	80
151	Siirt_2007	14,278	291,528	173,770	4,564	3.03E+06	58	4.11	0	4,009	8	324
152	Siirt_2008	12,581	299,819	178,960	5,154	3.16E+06	43	4.11	0	903	4	324
153	Sivas_2004	7,804	688,447	418,468	3,508	2.74E+07	9	2.62	0	12,866	33	827
154	Sivas_2005	39,413	671,786	417,634	4,302	2.73E+07	4	2.62	0	19,447	39	764
155	Sivas_2006	18,716	655,125	416,800	4,677	2.72E+07	34	2.62	0	21,701	47	689
156	Sivas_2007	101,959	638,464	415,961	5,730	2.70E+07	58	2.62	0	35,123	48	732
157	Sivas_2008	124,357	631,112	405,769	6,470	2.71E+07	43	2.62	0	40,489	52	1,200
158	Sivas_2009	124,137	633,347	417,756	5,300	2.78E+07	49	2.62	0	37,391	52	1,247
159	Şanlıurfa-Gap_2005	42,281	1,500,337	897,634	3,146	2.46E+07	4	3.05	0	32,392	67	1,940
160	Şanlıurfa-Gap_2006	84,542	1,511,720	908,735	3,420	2.54E+07	34	3.05	0	45,922	85	1,812
161	Şanlıurfa-Gap_2007	114,681	1,523,099	919,832	4,190	2.61E+07	58	3.05	0	85,982	80	1,669
162	Şanlıurfa-Gap_2008	154,657	1,574,224	885,929	4,732	2.74E+07	43	3.05	0	140,363	92	2,351
163	Şanlıurfa-Gap_2009	181,155	1,613,737	899,774	3,876	2.86E+07	49	3.05	0	128,431	123	2,547
164	Tekirdağ-Çorlu_2001	97,253	638,564	409,515	2,498	1.62E+07	-12	1.76	1	239,074	160	2,207
165	Tekirdağ-Çorlu_2002	51,010	653,537	423,653	3,905	1.68E+07	1	1.76	1	298,731	172	1,712
166	Tekirdağ-Çorlu_2003	14,291	668,510	437,791	5,136	1.75E+07	13	1.76	1	347,296	171	1,122
167	Tekirdağ-Çorlu_2004	9,964	683,483	451,929	6,538	1.81E+07	9	1.76	0	365,354	183	1,062
168	Tekirdağ-Çorlu_2005	14,853	698,456	466,067	8,018	1.88E+07	4	1.76	0	369,256	218	875
169	Tekirdağ-Çorlu_2006	36,477	713,429	480,205	8,716	1.95E+07	34	1.76	0	441,775	236	1,131
170	Tekirdağ-Çorlu_2007	29,768	728,396	494,342	10,679	2.02E+07	58	1.76	0	525,206	286	1,624
171	Tekirdağ-Çorlu_2008	6,882	770,772	521,554	12,059	2.17E+07	43	1.76	0	526,384	292	2,079
172	Tekirdağ-Çorlu_2009	40,778	783,310	530,278	9,878	2.25E+07	49	1.76	0	483,255	283	2,028
173	Tokat_2006	11,958	650,337	358,178	4,653	3.54E+07	34	2.52	0	10,984	26	957
174	Tokat_2007	44,483	620,722	350,914	5,700	3.45E+07	58	2.52	0	16,461	30	406
175	Tokat_2008	21,828	617,158	346,058	6,437	3.48E+07	43	2.52	0	20,932	34	887
176	Trabzon_2001	405,509	941,628	467,196	1,506	1.33E+07	-12	3.73	1	206,408	152	3,034
177	Trabzon_2002	396,028	908,119	455,438	2,280	1.32E+07	1	3.73	1	234,075	164	2,999
178	Trabzon_2003	429,047	874,610	443,680	2,998	1.30E+07	13	3.73	1	329,833	168	2,211
179	Trabzon_2004	775,699	841,101	431,922	3,817	1.28E+07	9	3.73	0	560,096	154	2,937
180	Trabzon_2005	1,080,689	807,592	420,164	4,681	1.26E+07	4	3.73	0	965,882	144	4,364

Table N.1 Continued

NO	Airport Case	Passenger Number	Population	Urban Population	GDPPC (USD)	Gravity Model Coeff. (Ea.2/Km2)	Airline Profit. (USD /PAX)	Highway vs. Air Travel Duration	Taxes (1= YES)	Export Amount (USD)	Number of Export Comp. (Ea.)	Bed Capa. (Ea.)
181	Uşak_2006	14,158	332,429	212,238	5,119	5.46E+07	34	1.85	0	111,253	153	599
182	Uşak_2007	31,328	334,115	217,267	6,271	5.60E+07	58	1.85	0	114,935	146	645
183	Uşak_2008	25,305	334,111	217,567	7,081	5.67E+07	43	1.85	0	114,783	136	869
184	Uşak_2009	10,327	335,860	221,714	5,801	5.81E+07	49	1.85	0	96,701	131	918
185	Van-Ferit Melen_2005	294,547	950,489	493,196	2,692	8.02E+06	4	4.47	0	13,415	47	1,689
186	Van-Ferit Melen_2006	495,749	965,082	502,440	2,927	8.34E+06	34	4.47	0	15,306	56	1,478
187	Van-Ferit Melen_2007	549,521	979,671	511,678	3,586	8.66E+06	58	4.47	0	9,535	43	1,296
188	Van-Ferit Melen_2008	585,319	1,004,369	514,481	4,049	8.99E+06	43	4.47	0	11,995	34	1,292
189	Van-Ferit Melen_2009	745,493	1,022,310	527,525	3,317	9.33E+06	49	4.47	0	17,341	45	1,246

Table N.2 Final Data (Socioeconomic Categories and Geographic Locations)

NO	Socio econ. Cat.	AT	RA1	RA2	RA3	Geog. Location	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Airport Case
1	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Adıyaman_2005
2	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Adıyaman_2006
3	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Adıyaman_2007
4	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Adıyaman_2008
5	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Adıyaman_2009
6	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2001
7	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2002
8	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2003
9	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2004
10	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2005
11	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2006
12	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2007
13	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2008
14	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Ağrı_2009
15	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Çanakkale_2007
16	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Çanakkale_2008
17	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Çanakkale_2009
18	AT	1	0	0	0	AG	0	1	0	0	0	0	0	0	0	0	Denizli-Çardak_2001
19	AT	1	0	0	0	AG	0	1	0	0	0	0	0	0	0	0	Denizli-Çardak_2002
20	AT	1	0	0	0	AG	0	1	0	0	0	0	0	0	0	0	Denizli-Çardak_2003
21	AT	1	0	0	0	AG	0	1	0	0	0	0	0	0	0	0	Denizli-Çardak_2004
22	AT	1	0	0	0	AG	0	1	0	0	0	0	0	0	0	0	Denizli-Çardak_2005
23	AT	1	0	0	0	AG	0	1	0	0	0	0	0	0	0	0	Denizli-Çardak_2006
24	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2001
25	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2002
26	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2003
27	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2004
28	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2005
29	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2006
30	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2007
31	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2008
32	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Diyarbakır_2009
33	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2001
34	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2002
35	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2003
36	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2004
37	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2005

Table N.2 Continued

NO	Socio econ. Cat.	AT	RA1	RA2	RA3	Geog. Location	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Airport Case
38	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2006
39	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2007
40	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2008
41	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Elazığ_2009
42	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2001
43	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2002
44	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2003
45	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2004
46	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2005
47	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2006
48	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2007
49	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2008
50	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzincan_2009
51	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2001
52	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2002
53	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2003
54	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2004
55	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2005
56	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2006
57	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2007
58	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2008
59	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Erzurum_2009
60	AT	1	0	0	0	EM	0	0	1	0	0	0	0	0	0	0	Eskişehir_2007
61	AT	1	0	0	0	EM	0	0	1	0	0	0	0	0	0	0	Eskişehir_2008
62	AT	1	0	0	0	EM	0	0	1	0	0	0	0	0	0	0	Eskişehir_2009
63	AT	1	0	0	0	SEA	0	0	0	0	0	0	0	0	0	1	GaziAntep_2001
64	AT	1	0	0	0	SEA	0	0	0	0	0	0	0	0	0	1	GaziAntep_2002
65	AT	1	0	0	0	SEA	0	0	0	0	0	0	0	0	0	1	GaziAntep_2003
66	AT	1	0	0	0	SEA	0	0	0	0	0	0	0	0	0	1	GaziAntep_2004
67	AT	1	0	0	0	SEA	0	0	0	0	0	0	0	0	0	1	GaziAntep_2005
68	RA1	0	1	0	0	ME	0	0	0	1	0	0	0	0	0	0	Isparta-S.Demirel_2006
69	RA1	0	1	0	0	ME	0	0	0	1	0	0	0	0	0	0	Isparta-S.Demirel_2007
70	RA1	0	1	0	0	ME	0	0	0	1	0	0	0	0	0	0	Isparta-S.Demirel_2008
71	RA1	0	1	0	0	ME	0	0	0	1	0	0	0	0	0	0	Isparta-S.Demirel_2009
72	AT	1	0	0	0	ME	0	0	0	1	0	0	0	0	0	0	K.Maraş_2005
73	AT	1	0	0	0	ME	0	0	0	1	0	0	0	0	0	0	K.Maraş_2006
74	AT	1	0	0	0	ME	0	0	0	1	0	0	0	0	0	0	K.Maraş_2007
75	AT	1	0	0	0	ME	0	0	0	1	0	0	0	0	0	0	K.Maraş_2008

Table N.2 Continued

NO	Socio econ. Cat.	AT	RA1	RA2	RA3	Geog. Location	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Airport Case
76	AT	1	0	0	0	ME	0	0	0	1	0	0	0	0	0	0	K.Maraş_2009
77	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2001
78	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2002
79	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2003
80	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2004
81	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2005
82	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2006
83	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2007
84	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2008
85	RA3	0	0	0	1	NEA	0	0	0	0	0	0	0	1	0	0	Kars_2009
86	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2001
87	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2002
88	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2003
89	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2004
90	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2005
91	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2006
92	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2007
93	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2008
94	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Kayseri_2009
95	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2001
96	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2002
97	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2003
98	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2004
99	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2005
100	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2006
101	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2007
102	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2008
103	AT	1	0	0	0	CA	0	0	0	0	1	0	0	0	0	0	Konya_2009
104	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2001
105	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2002
106	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2003
107	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2004
108	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2005
109	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2006
110	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2007
111	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2008
112	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Malatya_2009
113	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2001
114	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2002

Table N.2 Continued

NO	Socio econ. Cat.	AT	RA1	RA2	RA3	Geog. Location	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Airport Case
115	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2003
116	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2004
117	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2005
118	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2006
119	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2007
120	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2008
121	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Mardin_2009
122	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2001
123	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2002
124	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2003
125	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2004
126	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2005
127	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2006
128	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2007
129	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2008
130	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Muş_2009
131	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2001
132	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2002
133	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2003
134	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2004
135	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2005
136	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2006
137	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2007
138	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2008
139	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Nevşehir_2009
140	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2001
141	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2002
142	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2003
143	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2004
144	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2005
145	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2006
146	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2007
147	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2008
148	AT	1	0	0	0	WBS	0	0	0	0	0	1	0	0	0	0	Samsun-Çarşamba_2009
149	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Siirt_2005
150	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Siirt_2006
151	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Siirt_2007

Table N.2 Continued

NO	Socio econ. Cat.	AT	RA1	RA2	RA3	Geog. Location	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Airport Case
152	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Siirt_2008
153	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Sivas_2004
154	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Sivas_2005
155	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Sivas_2006
156	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Sivas_2007
157	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Sivas_2008
158	RA2	0	0	1	0	CA	0	0	0	0	1	0	0	0	0	0	Sivas_2009
159	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Şanlıurfa-Gap_2005
160	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Şanlıurfa-Gap_2006
161	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Şanlıurfa-Gap_2007
162	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Şanlıurfa-Gap_2008
163	RA3	0	0	0	1	SEA	0	0	0	0	0	0	0	0	0	1	Şanlıurfa-Gap_2009
164	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2001
165	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2002
166	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2003
167	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2004
168	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2005
169	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2006
170	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2007
171	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2008
172	RA1	0	1	0	0	WM	1	0	0	0	0	0	0	0	0	0	Tekirdağ-Çorlu_2009
173	RA2	0	0	1	0	WBS	0	0	0	0	0	1	0	0	0	0	Tokat_2006
174	RA2	0	0	1	0	WBS	0	0	0	0	0	1	0	0	0	0	Tokat_2007
175	RA2	0	0	1	0	WBS	0	0	0	0	0	1	0	0	0	0	Tokat_2008
176	AT	1	0	0	0	EBS	0	0	0	0	0	0	1	0	0	0	Trabzon_2001
177	AT	1	0	0	0	EBS	0	0	0	0	0	0	1	0	0	0	Trabzon_2002
178	AT	1	0	0	0	EBS	0	0	0	0	0	0	1	0	0	0	Trabzon_2003
179	AT	1	0	0	0	EBS	0	0	0	0	0	0	1	0	0	0	Trabzon_2004
180	AT	1	0	0	0	EBS	0	0	0	0	0	0	1	0	0	0	Trabzon_2005
181	RA1	0	1	0	0	AG	0	1	0	0	0	0	0	0	0	0	Uşak_2006
182	RA1	0	1	0	0	AG	0	1	0	0	0	0	0	0	0	0	Uşak_2007
183	RA1	0	1	0	0	AG	0	1	0	0	0	0	0	0	0	0	Uşak_2008
184	RA1	0	1	0	0	AG	0	1	0	0	0	0	0	0	0	0	Uşak_2009
185	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Van-Ferit Melen_2005
186	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Van-Ferit Melen_2006
187	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Van-Ferit Melen_2007
188	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Van-Ferit Melen_2008
189	RA3	0	0	0	1	CEA	0	0	0	0	0	0	0	0	1	0	Van-Ferit Melen_2009

APPENDIX O

CORRELATIONS

Table O.1 Correlations

		b11 AT	b11 RA2	b12 RA3	b12 2	b12 4	b12 5	b12 6	b12 7	b12 8	b12 9
b11 Anatolian Tigers	Pearson Correlation	1	-.193	-.634	-.155	.209	.146	.289	.283	.231	-.289
b11 RA2	Pearson Correlation	-.193	1	-.339	-.083	-.041	-.071	.564	.138	-.058	-.155
b12 RA3	Pearson Correlation	-.634	-.339	1	-.272	-.133	-.234	-.480	-.272	-.129	.456
b12 2	Pearson Correlation	-.155	-.083	-.272	1	-.033	-.057	-.118	-.067	-.046	-.124
b12 4	Pearson Correlation	.209	-.041	-.133	-.033	1	-.028	-.057	-.033	-.023	-.061
b12 5	Pearson Correlation	.146	-.071	-.234	-.057	-.028	1	-.101	-.057	-.040	-.107
b12 6	Pearson Correlation	.289	.564	-.480	-.118	-.057	-.101	1	-.118	-.082	-.219
b12 7	Pearson Correlation	.283	.138	-.272	-.067	-.033	-.057	-.118	1	-.046	-.124
b12 8	Pearson Correlation	.231	-.058	-.129	-.046	-.023	-.040	-.082	-.046	1	-.086
b12 9	Pearson Correlation	-.289	-.155	.456	-.124	-.061	-.107	-.219	-.124	-.086	1
b12 10	Pearson Correlation	-.269	-.144	.424	-.115	-.056	-.099	-.204	-.115	-.080	-.215
b12 11	Pearson Correlation	-.144	-.157	.332	-.126	-.062	-.108	-.223	-.126	-.088	-.235
b5 Airliner Profit	Pearson Correlation	-.148	.055	-.016	.040	.134	.152	-.029	.025	-.114	-.072
Ln b1 Population	Pearson Correlation	.567	-.268	-.258	-.039	.014	-.005	.143	.182	.086	-.406
Ln b3 GDPPC	Pearson Correlation	.159	.184	-.486	.288	.214	.166	.185	.096	-.041	-.367
Ln b4 Gravity Coef	Pearson Correlation	.660	.095	-.772	.077	.237	.094	.472	.235	-.053	-.501
Ln b6 Land vs Air	Pearson Correlation	-.329	-.216	.764	-.351	-.174	-.088	-.303	-.131	.108	.425
Ln b8 Export Amount	Pearson Correlation	.548	-.127	-.557	.196	.130	.127	.159	.054	.166	-.426
Ln b9 Export Companies	Pearson Correlation	.657	-.081	-.664	.155	.108	.090	.318	.073	.091	-.485
Ln b10 Bed Capacity	Pearson Correlation	.295	.233	-.458	.078	.035	-.078	.410	-.110	.144	-.136

Table O.1 Continued

		b12 10	b12 11	b5 Air liner Profit	Ln b1 Popul.	Ln b3 GDPP	Ln b4 Gravity Coef	Ln b6 Land vs Air	Ln b8 Export	Ln b9 Export Compa nies	Ln b10 Bed Capacity
b11_Anatolian Tigers	Pearson Correlation	-.269	-.144	-.148	.567	.159	.660	-.329	.548	.657	.295
b11_RA2	Pearson Correlation	-.144	-.157	.055	-.268	.184	.095	-.216	-.127	-.081	.233
b12_RA3	Pearson Correlation	.424	.332	-.016	-.258	-.486	-.772	.764	-.557	-.664	-.458
b12_2	Pearson Correlation	-.115	-.126	.040	-.039	.288	.077	-.351	.196	.155	.078
b12_4	Pearson Correlation	-.056	-.062	.134	.014	.214	.237	-.174	.130	.108	.035
b12_5	Pearson Correlation	-.099	-.108	.152	-.005	.166	.094	-.088	.127	.090	-.078
b12_6	Pearson Correlation	-.204	-.223	-.029	.143	.185	.472	-.303	.159	.318	.410
b12_7	Pearson Correlation	-.115	-.126	.025	.182	.096	.235	-.131	.054	.073	-.110
b12_8	Pearson Correlation	-.080	-.088	-.114	.086	-.041	-.053	.108	.166	.091	.144
b12_9	Pearson Correlation	-.215	-.235	-.072	-.406	-.367	-.501	.425	-.426	-.485	-.136
b12_10	Pearson Correlation	1	-.218	-.020	-.097	-.175	-.304	.262	-.303	-.291	-.310
b12 11	Pearson Correlation	-.218	1	-.010	.236	-.125	-.172	.314	.070	.011	-.106
b5 Airliner Profit	Pearson Correlation	-.020	-.010	1	-.076	.654	.090	-.072	.163	.043	-.041
Ln b1 Population	Pearson Correlation	-.097	.236	-.076	1	.099	.611	-.151	.608	.702	.331
Ln b3 GDPP	Pearson Correlation	-.175	-.125	.654	.099	1	.507	-.529	.539	.458	.293
Ln b4 Gravity Coef	Pearson Correlation	-.304	-.172	.090	.611	.507	1	-.766	.683	.814	.542
Ln b6 Highway vs Air	Pearson Correlation	.262	.314	-.072	-.151	-.529	-.766	1	-.502	-.599	-.474
Ln b8 Export	Pearson Correlation	-.303	.070	.163	.608	.539	.683	-.502	1	.928	.464
Ln b9 Export Companies	Pearson Correlation	-.291	.011	.043	.702	.458	.814	-.599	.928	1	.544
Ln b10 Bed Capacity	Pearson Correlation	-.310	-.106	-.041	.331	.293	.542	-.474	.464	.544	1

APPENDIX P

ESTIMATIONS OF THE MODELS

Table P.1 Estimations of the Models

Airport Case	Actual Passenger Number	Regression Model Prediction	Neural Model Prediction
Adıyaman_2005	6,864	40,794	14,265
Adıyaman_2006	37,669	52,770	20,388
Adıyaman_2007	48,621	74,024	39,726
Adıyaman_2008	86,280	74,999	38,961
Adıyaman_2009	85,112	65,389	32,509
Ağrı_2001	8,538	19,563	17,133
Ağrı_2002	9,312	31,996	20,137
Ağrı_2003	8,307	41,786	23,376
Ağrı_2004	9,576	53,936	51,199
Ağrı_2005	12,736	50,906	48,545
Ağrı_2006	22,884	57,164	70,026
Ağrı_2007	42,621	87,538	113,454
Ağrı_2008	60,360	73,063	96,069
Ağrı_2009	14,169	62,439	85,364
Çanakkale_2007	41,079	62,191	12,517
Çanakkale_2008	21,259	60,052	12,239
Çanakkale_2009	19,207	54,274	11,331
Denizli-Çardak_2001	35,397	17,993	35,109
Denizli-Çardak_2002	34,600	29,547	37,323
Denizli-Çardak_2003	37,741	38,885	37,484
Denizli-Çardak_2004	46,119	48,003	61,018
Denizli-Çardak_2005	66,276	55,143	83,356
Denizli-Çardak_2006	129,694	72,203	95,591
Diyarbakır_2001	222,221	89,075	168,485
Diyarbakır_2002	185,262	133,667	217,820
Diyarbakır_2003	211,750	170,754	281,767
Diyarbakır_2004	495,942	202,357	529,099
Diyarbakır_2005	676,098	233,005	623,674
Diyarbakır_2006	843,852	315,225	776,588

Table P.1 Continued

Airport Case	Actual Passenger Number	Regression Model Prediction	Neural Model Prediction
Diyarbakır_2007	895,625	454,740	918,286
Diyarbakır_2008	967,088	497,694	961,321
Diyarbakır_2009	1,060,381	454,810	916,019
Elazığ_2001	56,593	24,725	26,409
Elazığ_2002	46,238	84,721	42,099
Elazığ_2003	40,709	142,542	58,255
Elazığ_2004	39,007	165,678	104,952
Elazığ_2005	45,303	175,744	101,776
Elazığ_2006	69,578	189,241	153,017
Elazığ_2007	119,877	266,098	199,757
Elazığ_2008	135,293	263,048	168,300
Elazığ_2009	344,844	248,969	187,332
Erzincan_2001	12,023	8,142	9,079
Erzincan_2002	6,712	12,051	9,709
Erzincan_2003	8,377	16,315	11,043
Erzincan_2004	10,253	18,198	18,341
Erzincan_2005	21,097	17,309	23,112
Erzincan_2006	41,326	24,676	37,230
Erzincan_2007	64,681	31,398	64,924
Erzincan_2008	91,540	29,997	72,413
Erzincan_2009	127,030	27,667	53,631
Erzurum_2001	103,917	72,923	57,515
Erzurum_2002	94,610	110,423	73,008
Erzurum_2003	104,821	147,582	99,828
Erzurum_2004	217,984	171,958	268,655
Erzurum_2005	303,751	204,320	309,778
Erzurum_2006	453,013	270,069	495,661
Erzurum_2007	591,105	351,047	592,785
Erzurum_2008	527,598	344,994	521,417
Erzurum_2009	599,017	314,825	565,083
Eskişehir_2007	15,504	35,883	57,342
Eskişehir_2008	45,477	39,971	56,557
Eskişehir_2009	78,323	38,503	75,429
GaziAntep_2001	212,273	129,012	200,812
GaziAntep_2002	271,975	209,364	216,289
GaziAntep_2003	223,303	261,503	256,021
GaziAntep_2004	411,213	342,611	302,997
GaziAntep_2005	210,539	461,221	316,625
Isparta-S.Demirel_2006	38,258	14,393	6,525
Isparta-S.Demirel_2007	47,564	19,813	6,684

Table P.1 Continued

Airport Case	Actual Passenger Number	Regression Model Prediction	Neural Model Prediction
Isparta-S.Demirel_2008	15,053	18,879	6,644
Isparta-S.Demirel_2009	16,461	18,059	6,616
K.Maraş_2005	6,005	26,929	15,975
K.Maraş_2006	33,787	41,190	26,265
K.Maraş_2007	46,861	64,210	56,199
K.Maraş_2008	68,167	61,792	64,542
K.Maraş_2009	81,420	55,607	52,423
Kars_2001	51,743	22,931	20,287
Kars_2002	46,941	35,863	27,712
Kars_2003	54,312	44,567	35,619
Kars_2004	86,281	53,814	70,113
Kars_2005	162,158	84,493	104,377
Kars_2006	270,052	113,651	137,092
Kars_2007	95,421	153,936	154,535
Kars_2008	269,095	105,232	132,422
Kars_2009	288,008	92,702	122,021
Kayseri_2001	180,802	100,949	179,015
Kayseri_2002	242,134	156,078	247,548
Kayseri_2003	324,959	193,599	301,929
Kayseri_2004	467,326	217,445	470,725
Kayseri_2005	541,956	265,635	605,028
Kayseri_2006	681,107	407,356	673,843
Kayseri_2007	765,306	635,761	767,405
Kayseri_2008	674,833	689,447	830,281
Kayseri_2009	778,639	644,914	781,082
Konya_2001	82,991	95,263	63,023
Konya_2002	58,112	138,802	73,014
Konya_2003	78,162	187,059	88,867
Konya_2004	94,678	232,496	138,926
Konya_2005	167,252	272,174	175,789
Konya_2006	262,561	408,799	207,782
Konya_2007	248,070	586,310	263,786
Konya_2008	266,143	597,718	313,925
Konya_2009	301,724	554,991	222,566
Malatya_2001	84,193	42,127	42,317
Malatya_2002	87,512	69,806	51,752
Malatya_2003	89,545	85,486	61,077
Malatya_2004	140,230	112,852	200,707
Malatya_2005	304,565	129,434	206,223
Malatya_2006	406,425	153,534	287,995

Table P.1 Continued

Airport Case	Actual Passenger Number	Regression Model Prediction	Neural Model Prediction
Malatya_2007	421,444	258,594	483,126
Malatya_2008	463,817	238,045	464,601
Malatya_2009	462,884	219,207	443,762
Mardin_2001	31,895	20,883	11,492
Mardin_2002	25,930	34,807	11,977
Mardin_2003	19,538	45,261	13,245
Mardin_2004	22,060	52,018	28,691
Mardin_2005	41,256	52,574	32,936
Mardin_2006	115,626	86,276	73,121
Mardin_2007	191,383	130,326	189,926
Mardin_2008	192,764	137,380	186,701
Mardin_2009	233,288	125,022	183,970
Muş_2001	16,834	14,136	17,651
Muş_2002	17,300	16,098	18,715
Muş_2003	18,142	26,707	21,772
Muş_2004	34,227	30,928	34,558
Muş_2005	28,362	34,582	36,337
Muş_2006	35,984	47,777	51,451
Muş_2007	23,905	66,791	81,558
Muş_2008	88,875	54,648	69,173
Muş_2009	115,795	49,058	66,356
Nevşehir_2001	19,430	12,112	16,502
Nevşehir_2002	16,703	18,484	16,904
Nevşehir_2003	15,781	25,438	18,954
Nevşehir_2004	9,932	30,425	30,388
Nevşehir_2005	17,126	34,140	29,945
Nevşehir_2006	27,832	43,788	38,036
Nevşehir_2007	54,054	68,110	75,512
Nevşehir_2008	100,762	65,604	64,013
Nevşehir_2009	122,753	60,304	70,871
Samsun-Çarşamba_2001	174,638	102,498	89,457
Samsun-Çarşamba_2002	171,648	131,580	108,278
Samsun-Çarşamba_2003	175,300	234,272	171,891
Samsun-Çarşamba_2004	294,710	283,702	336,169
Samsun-Çarşamba_2005	384,434	310,047	423,616
Samsun-Çarşamba_2006	483,089	426,834	467,917
Samsun-Çarşamba_2007	555,796	524,672	551,182
Samsun-Çarşamba_2008	604,387	431,275	655,944
Samsun-Çarşamba_2009	866,862	380,746	540,164
Siirt_2005	11,994	8,076	30,945
Siirt_2006	18,097	10,946	49,070
Siirt_2007	14,278	35,201	80,883
Siirt_2008	12,581	35,312	86,113

Table P.1 Continued

Airport Case	Actual Passenger Number	Regression Model Prediction	Neural Model Prediction
Sivas_2004	7,804	16,244	12,759
Sivas_2005	39,413	17,220	13,801
Sivas_2006	18,716	21,241	16,677
Sivas_2007	101,959	30,431	27,081
Sivas_2008	124,357	39,218	26,101
Sivas_2009	124,137	36,215	25,442
Şanlıurfa-Gap_2005	42,281	123,498	102,769
Şanlıurfa-Gap_2006	84,542	160,017	114,303
Şanlıurfa-Gap_2007	114,681	217,410	166,610
Şanlıurfa-Gap_2008	154,657	267,050	195,197
Şanlıurfa-Gap_2009	181,155	257,401	139,976
Tekirdağ-Çorlu_2001	97,253	7,646	8,479
Tekirdağ-Çorlu_2002	51,010	10,562	8,187
Tekirdağ-Çorlu_2003	14,291	11,429	7,959
Tekirdağ-Çorlu_2004	9,964	13,264	10,335
Tekirdağ-Çorlu_2005	14,853	13,711	10,490
Tekirdağ-Çorlu_2006	36,477	21,696	16,326
Tekirdağ-Çorlu_2007	29,768	38,554	43,832
Tekirdağ-Çorlu_2008	6,882	45,751	60,975
Tekirdağ-Çorlu_2009	40,778	41,187	43,555
Tokat_2006	11,958	44,964	26,114
Tokat_2007	44,483	37,196	36,748
Tokat_2008	21,828	56,891	33,971
Trabzon_2001	405,509	328,058	365,491
Trabzon_2002	396,028	482,267	427,186
Trabzon_2003	429,047	529,461	419,809
Trabzon_2004	775,699	708,048	713,551
Trabzon_2005	1,080,689	973,844	796,617
Uşak_2006	14,158	19,004	6,613
Uşak_2007	31,328	28,197	7,076
Uşak_2008	25,305	32,777	7,472
Uşak_2009	10,327	30,604	6,920
Van-Ferit Melen_2005	294,547	285,677	327,951
Van-Ferit Melen_2006	495,749	358,950	513,229
Van-Ferit Melen_2007	549,521	477,184	639,411
Van-Ferit Melen_2008	585,319	476,448	554,436
Van-Ferit Melen_2009	745,493	426,725	662,127
Z_Or_Gi_2009		371,232	598,986
Zafer_2_2009		142,332	172,532
Zafer_3_2009		186,073	200,768
Z_Or_Gi_2020		987,971	934,781
Zafer_2_2020		230,567	217,387
Zafer_3_2020		306,274	322,167